Holston Army Ammunition Plant
Kingsport
Hawkins County AND SULLIVAN COUNTY
Tennessee

HAER No. TN-10

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WRITTEN HISTORICAL AND DESCRIPTIVE DATA

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Historic American Engineering Record
National Park Service
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HISTORIC AMERICAN ENGINEERING RECORD

Holston Army Ammunition Plant

TN-10

Location:	In Sullivan County, Tennessee, along the Holston River, South and west of Kingsport.
Date of Construction:	Established in 1942-1944
Owner:	Department of the Army
Significance:	During World War II, the Holston Army Ammunition Plant made several significant contributions to explosives-manufacturing technology. It was the first large-scale facility to implement the nearly developed Bachmann process in the manufacture of the explosive RDX. At the same time, it streamlined the Bachmann method by instituting a slurry-based, continuous manufacturing process, and it also developed important new cooling and packaging procedures for composition B. As a result of these innovations, Holston became the world's largest producer of Composition B, the most powerful explosive until the development of nuclear weapons.
Historical Report Prepared by:	Jeffrey A. Hess, 1984.
Prepared for Transmittal by:	Robie S. Lange, HABS/HAER, 1985.

EXECUTIVE SUMMARY

The Holston Army Ammunition Plant (HSAAP) is part of the Army's Armament, Munitions and Chemical Command (AMCCOM). It is the only American manufacturing facility for RDX- and HMX-based high explosives. Its chief product is Composition B. The installation consists of two separate areas -- Plant A (120 acres) and Plant B (5,900 acres) -- situated in and near Kingsport, Tennessee. Except for a four-year standby period immediately following V-J Day, the facility has been in continuous production since its initial construction in 1942-1944. Of the 470 buildings maintained by the installation, approximately three-quarters date from the World-War-II period.

As the world's first large-scale Bachmann-method plant, the Holston Army Ammunition Plant revolutionized the production of RDX and Composition B by replacing an expensive, labor-intensive technology with a cost-efficient, mass-production operation. It also pioneered in the development of the magnesium-nitrate method of nitric acid concentration. During World War II, the installation was of critical importance to Allied strategic planning, and its large output of Composition B hastened Allied victory in the crucial Battle of the Atlantic.

Because of their great technological and historical importance, the ten RDX and Composition-B manufacturing lines (Buildings B1, B3, B5, B7, B9, C1, C3, C5, C6, C7, C9, D1-D10, E1-E10, G1-G10, H1-H10, I1-I10, J1-J10, K1-K10, L1-L10, M1-M10, O1, O3, O5, O7, O9, N1-N10) at Plant B are Category I historic properties. The installation also contains one of the nation's few surviving producer-gas plants (Plant A, Building 10), which is a Category I historic property by virtue of its rarity and highly intact condition. The installation's Old Administration Building (Plant B, Building 1) is a Category III historic property because of its role in overseeing the World-War-II manufacturing operation. There are no Category II historic properties at the installation.

CONTENTS

PREFACE

This report presents the results of an historic properties survey of the Holston Army Ammunition Plant. Prepared for the United States Army Materiel Development and Readiness Command (DARCOM), the report is intended to assist the Army in bringing this installation into compliance with the National Historic Preservation Act of 1966 and its amendments, and related federal laws and regulations. To this end, the report focuses on the identification, evaluation, documentation, nomination, and preservation of historic properties at the Holston Army Ammunition Plant. Chapter 1 sets forth the survey's scope and methodology; Chapter 2 presents an architectural, historical, and technological overview of the installation and its properties; and Chapter 3 identifies significant properties by Army category and sets forth preservation recommendations. Illustrations and an annotated bibliography supplement the text.

This report is part of a program initiated through a memorandum of agreement between the National Park Service, Department of the Interior, and the U.S. Department of the Army. The program covers 74 DARCOM installations and has two components: 1) a survey of historic properties (districts, buildings, structures, and objects), and 2) the development of archaeological overviews. Stanley H. Fried, Chief, Real Estate Branch of Headquarters DARCOM, directed the program for the Army, and Dr. Robert J. Kapsch, Chief of the Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER) directed the program for the National Park Service. Sally Kress Tompkins was program manager, and Robie S. Lange was

project manager for the historic properties survey. Technical assistance was provided by Donald C. Jackson.

Building Technology Incorporated acted as primary contractor to HABS/HAER for the historic properties survey. William A. Brenner was BTI's principal-in-charge and Dr. Larry D. Lankton was the chief technical consultant. Major subcontractors were the MacDonald and Mack Partnership and Jeffrey A. Hess. The author of this report was Jeffrey A. Hess. The author gratefully acknowledges the help of Lt. Col. Willis Seguin, Plant Commander; William D. Miller and Susan P. Cole of the government staff; and T.W. Goodwin, Jerry Blair, Henry Hurd, Roy S. Easton, Robert Brewer, Jr., Robert Wicker, and Ken Curtis of the Holston Defense Corporation.

The complete HABS/HAER documentation for this installation will be included in the HABS/HAER collections at the Library of Congress, Prints and Photographs Division, under the designation HAER No. TN-10.

Chapter 1

INTRODUCTION

SCOPE

This report is based on an historic properties survey conducted in April 1983 of all Army-owned properties located within the official boundaries of the Holston Army Ammunition Plant. The survey included the following tasks:

- Completion of documentary research on the history of the installation and its properties.
- Completion of a field inventory of all properties at the installation.
- Preparation of a combined architectural, historical, and technological overview for the installation.
- Evaluation of historic properties and development of recommendations for preservation of these properties.

Also completed as a part of the historic properties survey of the installation, but not included in this report, are HABS/HAER Inventory cards for 27 individual properties. These cards, which constitute HABS/HAER Documentation Level IV, will be provided to the Department of the Army. Archival copies of the cards, with their accompanying photographic negatives, will be transmitted to the HABS/HAER collections at the Library of Congress.

The methodology used to complete these tasks is described in the following section of this report.

METHODOLOGY

1. Documentary Research

The Holston Army Ammunition Plant (HSAAP) was constructed during 1942-1944 as a government-owned, contractor-operated facility designed to manufacture the high explosive Composition B and its chief ingredient RDX. In addition to these major products, the HSAAP also manufactured several raw materials used in RDX production. These subsidiary operations involved the production of acetic acid, acetic anhydride, ammonium nitrate, nitric acid, and producer gas. To place the HSAAP in proper historical and technological perspective, research was conducted on virtually all manufacturing processes employed at the installation. Published doumentary sources were identified by consulting standard bibliographies of military history, engineering, and the applied sciences. Unpublished sources were identified by researching the historical and technological archives of the U.S. Army Armament, Munitions and Chemical Command (AMCCOM) at Rock Island Arsenal.[1]

A concerted effort was also made to locate published and unpublished sources dealing specifically with the architecture and history of the HSAAP. This site-specific research was conducted primarily at the AMCCOM Historical Office at Rock Island Arsenal, the Kingsport Public Library (Palmer Room), and the HSAAP (contractor's archives, government administrative archives, real property records office, facilities engineer's office). The Tennessee State Historic Preservation Office (Tennessee Historical Commission, Nashville) was contacted for information about the HSAAP, but had no relevant data.[2]

Army records used for the field inventory included current Real Property Inventory (RPI) printouts that listed all officially recorded buildings and structures by facility classification and date of construction; the installation's property record cards; base maps and photographs supplied by installation personnel; and installation master planning, archaeological, environmental assessment, and related reports and documents. A complete listing of this documentary material may be found in the bibliography.

2. <u>Field Inventory</u>

Architectural and technological field surveys were conducted in April 1983 by Jeffrey A. Hess and Robert C. Mack. Following General discussions with William Miller, environmental affairs officer of the government staff, and T. W. Goodwin, manager of the contractor staff, the surveyors were provided with escorts for tours of the installation's production and magazine areas. The following contractor personnel served as guides: Ken Curtis (magazine areas), Henry Hurd (Plant-A production facilities), Robert Brewer, Jr. (Plant-A utilities), Jerry Blair (Plant-B RDX-and-Composition-B lines), and Robert Wicker (Plant-B acid area and utilities). The surveyors were permitted to inspect the installation's administration and shop areas on an unescorted basis.

Field inventory procedures were based on the HABS/HAER Guidelines for Inventories of Historic Buildings and Engineering and Industrial Structures.[2] All areas and properties were visually surveyed. Building locations and approximate dates of construction were noted from the installation's property records and field-verified. Interior surveys were made of the major facilities to permit adequate evaluation of architectural features, building technology, and production equipment.

Field inventory forms were prepared for, and black and white 35 mm photographs taken of all buildings and structures through 1945 except basic utilitarian structures of no architectural, historical, or technological interest. When groups of similar ("prototypical") buildings were found, one field form was normally prepared to represent all buildings of that type. Field inventory forms were also completed for representative post-1945 buildings and structures.[3] Information collected on the field forms was later evaluated, condensed, and transferred to HABS/HAER Inventory cards.

3. Historical Overview

A combined architectural, historical, and technological overview was prepared from information developed from the documentary research and the field inventory. It was written in two parts: 1) an introductory description of the installation, and 2) a history of the installation by periods of development, beginning with pre-military land uses. Maps and photographs were selected to supplement the text as appropriate.

The objectives of the overview were to 1) establish the periods of major construction at the installation, 2) identify important events and individuals associated with specific historic properties, 3) describe patterns and locations of historic property types, and 4) analyze specific building and industrial technologies employed at the installation.

4. Property Evaluation and Preservation Measures

Based on information developed in the historical overviews, properties were first evaluated for historical significance in accordance with the eligibility criteria for nomination to the National Register of Historic Places. These criteria require that eligible properties possess integrity of location, design, setting, materials, workmanship, feeling, and association, and that they meet one or more of the following:[4]

A. Are associated with events that have made a significant contribution to the broad patterns of our history.

B. Are associated with the lives of persons significant in the nation's past.

C. Embody the distinctive characteristics of a type, period, or method of construction, represent the work of a master, possess high artistic values, or represent a significant and distinguishable entity whose components may lack individual distinction.

D. Have yielded, or may be likely to yield, information important in pre-history or history.

Properties thus evaluated were further assessed for placement in one of five Army historic property categories as described in Army Regulation 420-40:[5]

Category I	Properties of major importance
Category II	Properties of importance
Category III	Properties of minor importance
Category IV	Properties of little or no importance
Category V	Properties detrimental to the significance of adjacent historic properties.

Based on an extensive review of the architectural, historical, and technological resources identified on DARCOM installations nationwide, four criteria were developed to help determine the appropriate categorization level for each Army property. These criteria were used to assess the importance not only of properties of traditional historical interest, but also of the vast number of standardized or prototypical buildings, structures and production processes that were built and put into service during World War II, as well as of properties associated with many post-war technological achievements. The four criteria were often used in combination and are as follows:

1) Degree of importance as a work of architectural, engineering, or industrial design. This criterion took into account the qualitative factors by which design is normally judged: artistic merit, workmanship, appropriate use of materials, and functionality.

2) Degree of rarity as a remaining example of a once widely used architectural, engineering, or industrial design or process. This criterion was applied primarily to the many standardized or prototypical DARCOM buildings, structures, or industrial processes. The more widespread or influential the design or process, the greater the importance of the remaining examples of the design or process was considered to be. This criterion was also used for non-military structures such as farmhouses and other once prevalent building types.

3) Degree of integrity or completeness. This criterion compared the current condition, appearance, and function of a building, structure, architectural assemblage, or industrial process to its original or most historically important condition, appearance, and function. Those properties that were highly intact were generally considered of greater importance than those that were not.

4) Degree of association with an important person, program, or event. This criterion was used to examine the relationship of a property to a famous personage, wartime project, or similar factor that lent the property special importance.

The majority of DARCOM properties were built just prior to or during World War II, and special attention was given to their evaluation. Those that still remain do not often possess individual importance, but collectively they represent the remnants of a vast construction undertaking whose architectural, historical, and technological importance needed to be assessed before their numbers diminished further. This assessment centered on an extensive review of the military construction of the 1940-1945 period, and its contribution to the history of World War II and the post-war Army landscape.

Because technology has advanced so rapidly since the war, post-World War II properties were also given attention. These properties were evaluated in terms of the nation's more recent accomplishments in weaponry, rocketry, electronics, and related technological and scientific endeavors. Thus the traditional definition of "historic" as a property 50 or more years old was not germane in the assessment of either World War II or post-war DARCOM buildings and structures; rather, the historic importance of all properties was evaluated as completely as possible regardless of age.

Property designations by category are expected to be useful for approximately ten years, after which all categorizations should be reviewed and updated.

Following this categorization procedure, Category I, II, and III historic properties were analyzed in terms of:

- Current structural condition and state of repair. This information was taken from the field inventory forms and photographs, and was often supplemented by rechecking with facilities engineering personnel.

- The nature of possible future adverse impacts to the property. This information was gathered from the installation's master planning documents and rechecked with facilities engineering personnel.

Based on the above considerations, the general preservation recommendations presented in Chapter 3 for Category I, II, and III historic properties were developed. Special preservation recommendations were created for individual properties as circumstances required.

5. Report Review

Prior to being completed in final form, this report was subjected to an in-house review by Building Technology Incorporated. It was then sent in draft to the subject installation for comment and clearance and, with its associated historical materials, to HABS/HAER staff for technical review. When the installation cleared the report, additional draft copies were sent to DARCOM, the appropriate State Historic Preservation Officer, and, when requested, to the archaeological contractor performing parallel work at the installation. The report was revised based on all comments collected, then published in final form.

NOTES

1. The following bibliographies of published sources were consulted: Industrial Arts Index, 1938-1957; Applied Science and Technology Index, 1958-1980; Engineering Index, 1938-1983; Robin Higham, ed., A Guide to the Sources of United States Military History (Hamden, Conn.: Archon Books, 1975); John E. Jessup and Robert W. Coakley, A Guide to the Study and Use of Military History (Washington, D.C.: U.S. Government Printing Office, 1979); "Military Installations," Public Works History in the United States, eds., Suellen M. Hoy and Michael C. Robinson (Nashville: American Association for State and Local History, 1982), pp. 380-400. AMCCOM (formerly ARRCOM, or U.S. Army Armament Materiel Readiness Command) is the military agency responsible for supervising the operation of government-owned munititions plants; its headquarters are located at Rock Island Arsenal, Rock Island, Illinois. Although there is no comprehensive index to AMCCOM archival holdings, the agency's microfiche collection of unpublished reports is itemized in ARRCOM, Catalog of Common Sources, Fiscal Year 1983, 2 vols. (no pl.: Historical Office, AMCCOM, Rock Island Arsenal, n.d.).

2. Historic American Buildings Survey/Historic American Engineering Record, National Park Service, Guidelines for Inventories of Historic Buildings and Engineering and Industrial Structures (unpublished draft, 1982).

3. Representative post-World War II buildings and structures were defined as properties that were: (a) "representative" by virtue of construction type, architectural type, function, or a combination of these, (b) of obvious Category I, II, or III historic importance, or (c) prominent on the installation by virtue of size, location, or other distinctive feature.

4. National Park Service, How to Complete National Register Forms (Washington, D.C.: U.S. Government Printing Office, January 1977).

5. Army Regulation 420-40, Historic Preservation (Headquarters, U.S. Army: Washington, D.C., 15 April 1984).

Chapter 2

HISTORICAL OVERVIEW

BACKGROUND

The HSAAP is a government-owned, contractor-operated installation constructed during 1942-1944 for the manufacture of the military, high explosive Composition B, and its chief ingredient RDX. The installation consists of two separate areas — Plant A and Plant B — located about four air miles apart on the Holston River in northeastern Tennessee (Figure 1). The two areas are connected by above-ground chemical pipelines and an inter-plant railroad. Plant A presently occupies about 120 acres in the heart of the manufacturing district of Kingsport in Sullivan County. It produces raw materials for and processes by-products from Plant B, which is situated upstream on about 5,900 acres in rural-suburban Hawkins County. Plant B contains a nitric-acid production area and ten explosives-manufacturing lines, as well as extensive facilities for storing and shipping explosives. It also houses the HSAAP's main administrative offices and maintenance shops.

During World War II, the HSAAP made several significant contributions to explosives-manufacturing technology. It was the first large-scale facility to implement the newly developed Bachmann process in the manufacture of RDX. At the same time, it streamlined the Bachmann method by instituting a slurry-based, continuous manufacturing process, and it also developed important new cooling and packaging procedures for Composition B. As a result of these innovations, the HSAAP became the world's largest producer

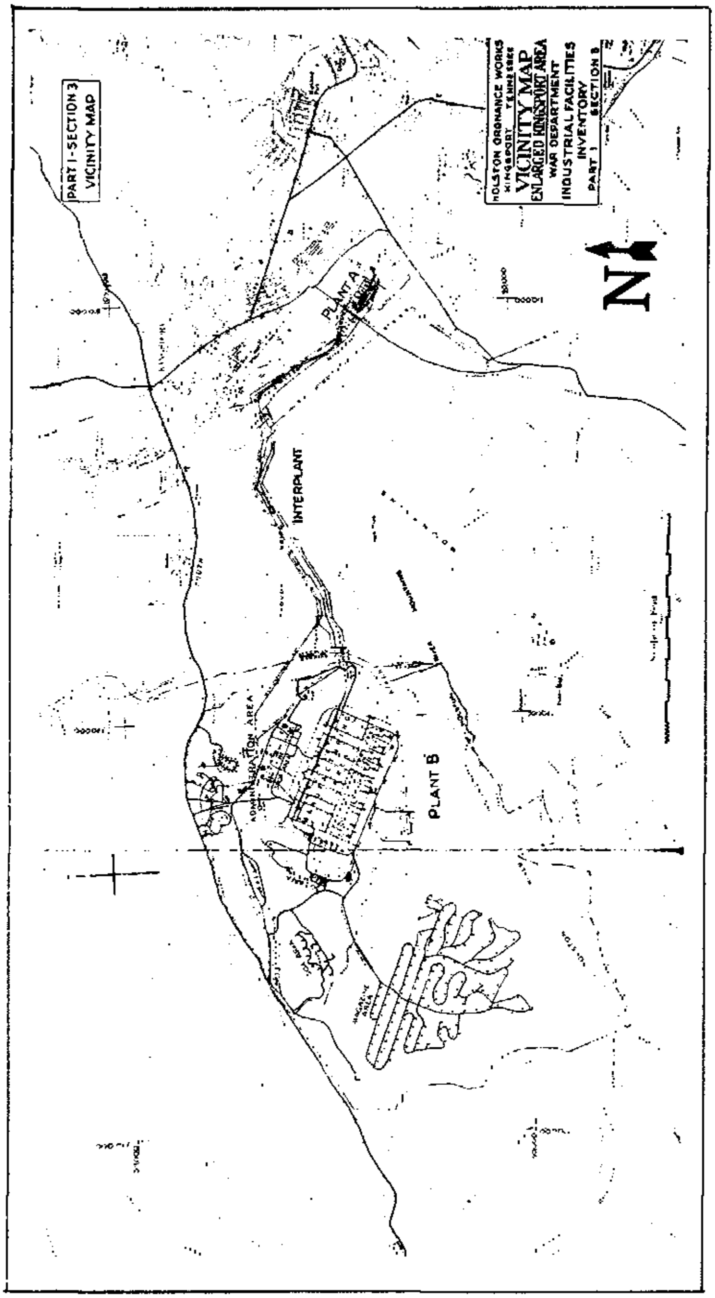

Figure 1: Vicinity map of the Holston Army Ammunition Plant. (Source: "Industrial Facilities Inventory," Part 1, Section 3, unpublished, prepared by U. S. Army Corps of Engineers, 1944, HSAAP Archives.)

of Composition B, the most powerful explosive known until the development of nuclear weapons. Used extensively in depth charges and torpedos, the plant's output hastened Allied victory in the crucial Battle of the Atlantic.[1] On a smaller scale, the HSAAP pioneered in the use of magnesium nitrate as a dehydrating-concentrating agent in nitric-acid production — a technique that would eventually lead to the commercial development of the "maggie unit."

Shortly after V-J Day, the HSAAP suspended manufacturing operations and assumed the status of a "standby" plant with its production equipment intact. Apart from the fabrication of ammonium-nitrate fertilizer in 1946-1947 for distribution under the Marshall Plan, the HSAAP's manufacturing lines remained inactive until 1949, when small-scale production of Composition B resumed. Since that time, the HSAAP has continued to turn out RDX-based explosives, with production dramatically expanding and contracting during and after the Korean and Vietnam Wars.

At present, the HSAAP comprises approximately 470 buildings, three-quarters of which date from the original construction period. About one-third of the structures are used for manufacturing; one-third for explosives storage; and the remaining third for administration, maintenance, and utilities. Despite the modification and modernization of several plant facilities, the HSAAP — in both architectural and technological terms — retains much of its original, World-War-II character. The installation also maintains and operates one of the country's few remaining producer-gas plants (Plant A, Building 10).

For a more detailed understanding of the HSAAP's architectural and technological history, it is necessary to look more closely at the installation's three major production periods: World War II, the Korean War and the Vietnam War. Whenever the available data permits, the discussion will focus on specific buildings and processes.

WORLD WAR II

In June 1940, shortly after the fall of France, President Roosevelt established the National Defense Research Committee (NDRC) to mobilize the nation's academic community for "research on the mechanisms and devices of warfare." In time, the NDRC would sponsor hundreds of research projects that ran the gamut from amphibious vehicles to rocket propellants. But initially it focused its attention on promising new technologies developed by the British, and this was particularly true in the area of high explosives.[2]

During the 1930's, British stategists had learned that German submarine hulls were being strengthened to withstand anything short of a direct hit by a conventional TNT-loaded depth charge. To counter the U-boat threat, the British Admiralty began seeking a more effective explosive, and its first choice was cyclonite. Discovered as early as 1899, cyclonite was known to be almost twice as powerful as TNT — but also several times more sensitive to shock, which prohibited its use in conventional ordnance. By the late 1930's, however, British scientists at the Armament Research Department at Woolwich Arsenal had determined that cyclonite could be sufficiently desensitized by combining it with wax, plasticizing oils, or TNT. As a security measure, the British rechristened cyclonite as "Research Department Explosive," or RDX. With a similar flair for anonymity, they chose the name of "Composition B" for the desensitized mixture of 60% RDX and 40% TNT that was to be widely used in Allied naval ordnance during World War II.[3]

Although the British were the first to tame cyclonite, they were less successful in devising an efficient means for mass producing it. The method developed at Woolwich Arsenal, and first employed on a large scale at Bridgewater, England in the summer of 1941, involved a simple batch process for the nitration of hexamine by concentrated nitric acid. Calling for eleven pounds of strong nitric acid for every pound of RDX produced, the Woolwich method required the construction of an enormous, on-site nitric-acid works, which made the process extremely expensive to implement and operate. While the Bridgewater plant was still under construction, the British encouraged the newly created NDRC to investigate a cheaper method of manufacturing RDX. The NDRC took up the challenge, and in November 1940, it selected Werner E. Bachmann, an organic chemist at the University of Michigan, to work on the project.[4]

Bachmann had no previous experience with munitions, and as he later declared, his "heart sank" at the prospect of working on an explosives project. Despite his personal distaste for the work, Bachmann threw himself into the study with such energy that within three months he had developed a new RDX-production process, involving the nitration of hexamine by a mixture of strong nitric acid and ammonium nitrate, with acetic anbydride added to serve as a dehydrating agent. Bachmann's discovery reduced the total nitric-acid requirements of the Woolwich method by fully 85% while doubling the RDX yield from hexamine. The new process, however, did have one drawback: it released, as a by-product, substantial quantities of weak acetic acid contaminated with RDX. Before the Bachmann method could become a practical manufacturing technique, it was necessary to devise a means of purifying the acetic acid, concentrating it, and reconverting it to acetic anhydride. The search for the solution to this problem led the NDRC to the Tennessee Eastman Corporation of Kingsport, Tennessee.[5]

A wholly-owned subsidiary of the Eastman Kodak Company of Rochester, New York, the Tennessee Eastman Corporation was a leading producer of both acetic anhydride and cellulose acetate, which it manufactured into synthetic yarn. In developing its cellulose-acetate facility, Tennessee Eastman had engineered an acetic-acid recovery system that seemed applicable to the Bachmann process. In November 1941, the NDRC requested Tennessee Eastman to join its RDX task force, and three months later, the company reported that it had worked out a feasible acid-recovery procedure. The firm was then asked to design and operate two pilot plants in Kingsport: one to manufacture RDX according to the Bachmann method, and the other to combine RDX and TNT into Composition B. Both plants were in production by the end of April 1942. Highly impressed with the company's expeditious handling of the pilot projects, the NDRC recommended that Tennessee Eastman be selected to design and operate the HSAAP, the country's first and only large-scale, Bachmann-method, RDX installation. A contract to this effect was signed by Tennessee Eastman and the United States government in June 1942.[6]

Site Selection and Former Land Use

The Kingsport area was selected as the site for the HSAAP primarily because it was the manufacturing base of the Tennessee Eastman Corporation, which would serve as contractor-operator of the new facility.[7] The site also satisfied the following basic criteria that governed the selection of other World-War-II explosives plants:

(1) availability of suitable labor without major housing projects;
(2) proximity to a main railroad line;
(3) availability of adequate electric power;
(4) ample supply of water for processing;
(5) availability of extended, isolated tracts for explosives manufacturing and storage;
(6) a location at least 200 miles from coastal waters and international borders as a defense against enemy attack.[8]

When the government began its acquisition of land for the HSAAP in the summer of 1942, the Plant-A site, immediately adjacent to the Tennessee Eastman Plant in Kingsport, was an unoccupied, industrially-zoned tract with no standing structures. The Plant-B site in rural Hawkins County was predominantly crop and pasture land that had long been used for dairying. It contained at least thirty-eight standing structures, including farmhouses, servants' quarters, garages, stables, barns, and a schoolhouse.

None of these buildings survive within the present boundaries of the HSAAP.[9]

Construction

Construction work on the HSAAP* commenced in the summer of 1942 under the general supervision of the U. S. Army Corps of Engineers, which created a special "Holston District" to administer the project. Since the HSAAP was the first large-scale facility to implement the Bachmann process, there were no precedents for its overall design. The preparation of engineering and construction specifications was further complicated by a phased completion schedule that called for the progressive activation of production lines. As one engineer on the project observed, "Holston was very literally designed, built and operated simultaneously."[10] The Corps of Engineers launched the project by letting two major contracts. The first went to Tennessee Eastman Corporation for "general layout of the plant, design of the manufacturing buildings, design and procurement of manufacturing equipment, and finally operation of the plant." The second contract was awarded to the New York architectural and engineering firm of Fraser-Brace Co., Inc., which had just completed a series of design and construction contracts for the expansion of the Weldon Springs Ordnance Works, a sprawling TNT plant in Missouri. Fraser-Brace agreed to serve as general contractor and project manager, and assumed direct responsibility for "all construction and equipment installation, all procurement (other

* Throughout World War II, the HSAAP was officially designated as the Holston Ordnance Works. The plant's current name, which dates from 1963, is used throughout this report for the sake of brevity and clarity.

than manufacturing equipment), and all design of temporary utilities and structures." For its principal subcontractor on the HSAAP project, Fraser-Brace selected the Boston architectural and engineering firm of Charles T. Main, Inc., which had previously handled the construction of Camp Edwards in Massachussets. At the HSAAP site, the Boston firm was responsible for the "design of roads, railroads, bridges, utilities, magazines and all buildings other than manufacturing, as well as field layout and field inspection."[11] By dividing design responsibility among three firms, the Corps of Engineers had hoped to promote flexibility and speed. In practice, however, the project was plagued by persistent confusion at the construction site, exacerbated by "an element of friction" between Fraser-Brace and its Boston associate.[12]

In July 1943, as the HSAAP was nearing completion, the government authorized a doubling of the installation's production capacity, which necessitated both the modification of existing, on-site equipment and the erection of several new structures. As a result of this expansion program, construction crews remained at the site until mid-March 1944, when "the project was finished, cleaned up and 100% in the hands of the operators."[13] At this time the Corps of Engineers took inventory of the new installation, and counted a total of 610 buildings. Of this number, 48 were located at Plant A (Figures 2, 3). Compactly clustered on a 134-acre site, the principal Plant-A structures comprised an Administration-Laboratory Building (Building a-1),* a Steam Plant (Building a-8), and Acetic-Acid

* Throughout this chapter, Plant-A and Plant-B buildings are distinguished, respectively, by the use of the lower-case prefixes "a" and "b."

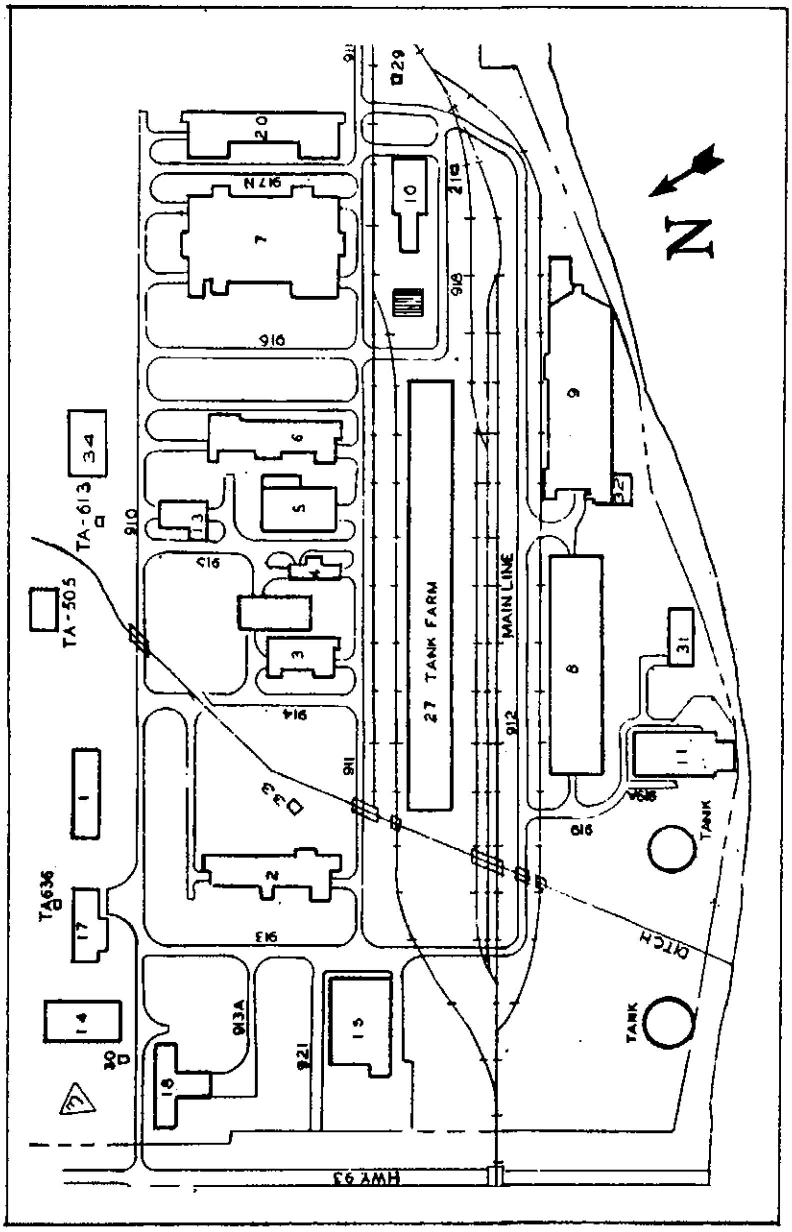

Figure 2: Building location plan of Plant A. (Source: Drawing No. 7651-212/1226.03, unpublished, prepared by Holston Defense Corporation, 1970, revised 1976, HSAAP Archives.)

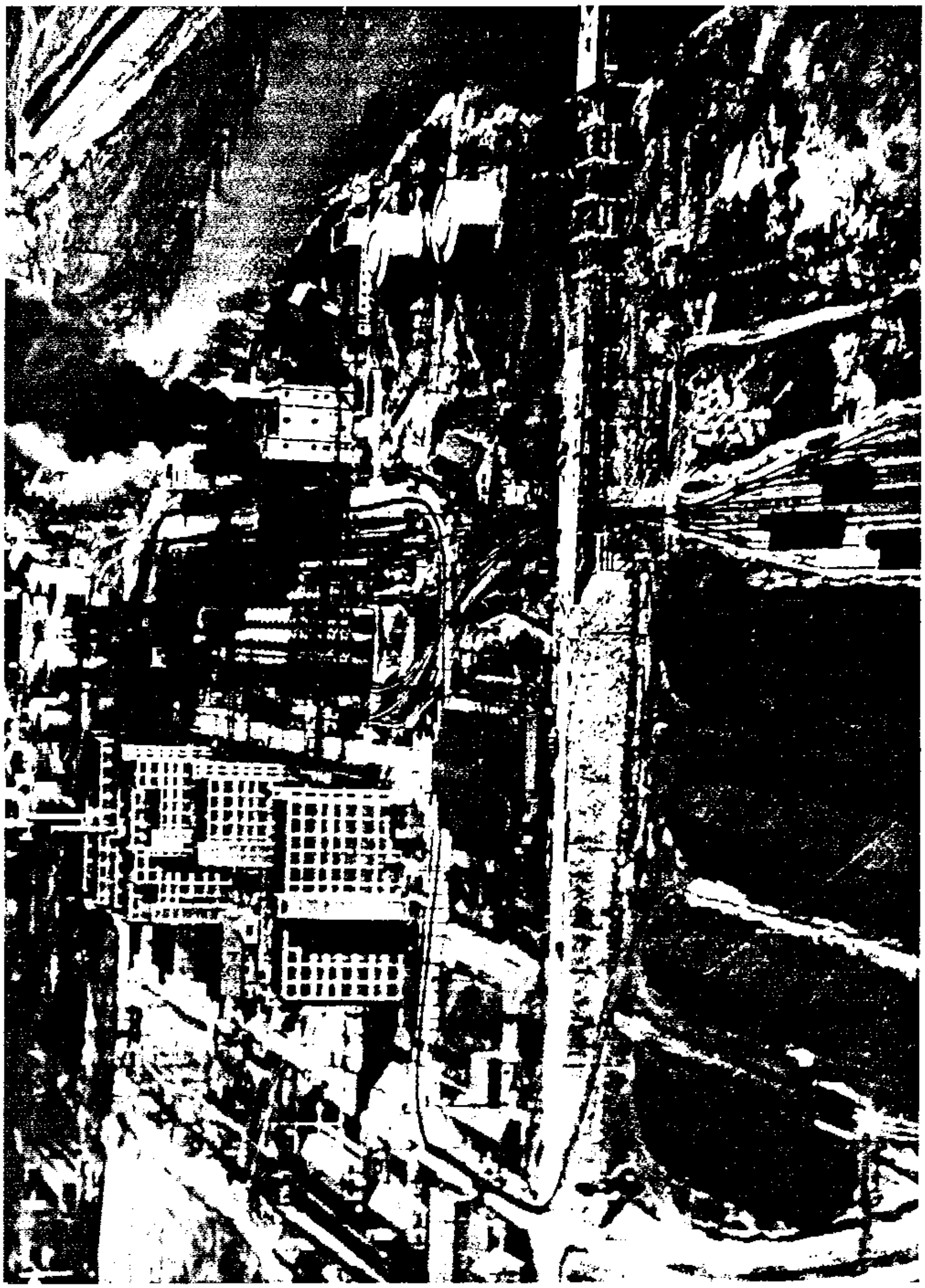

Figure 3: Aerial view of Plant A, looking south, 1944. The Acetic-Acid Concentration Plant (Building 2) is toward the foreground; the Steam Plant (Building 8) is toward the right. (Source: "Industrial Facilities Inventory," Part 1 Section 7, unpublished, prepared by U. S. Army Corps of Engineers, 1944, HSAAP Archives.)

Concentration Plant (Building a-2), an Acetic-Acid Production Plant (Building a-3), an Acetic-Acid Catalyst Building (Building a-4), a Refrigeration Plant (Building a-5), an Acetic-Anhydride Refining Plant (Building a-6), two Acetic-Anhydride Production Plants (Buildings a-7, a-20), and a Producer-Gas Plant (Building a-10).[14]

Occupying a 6,370-acre site,* the 562 buildings at Plant B were dispersed into six major areas according to their general function. The most centrally located area was devoted to manufacturing; it contained approximately 100 structures divided into ten production lines for RDX and Composition B (Figure 4). Bordering the manufacturing area on the north was a shop area and, further north, an administration area, which contained the HSAAP's Main Administration Building (Building b-1) (Figure 5), Personnel Building (Building b-2), Cafeteria (Building b-3), Hospital (Building b-4), Telephone Building (Building b-5), and Fire Station (Building b-7). Due west of the manufacturing area was a Steam Plant (Building b-200), and an "acid area" that produced nitric acid for the explosives-manufacturing lines. The principal structures in this part of the plant were an Air-Compressor Building (Building b-300), an Ammonia-Oxidation Building (Building b-302), a Nitric-Acid Concentration Building (Building b-303), and a Sulfuric-Acid Concentration Building (Building b-308). Still further west was a storage area for ammonium nitrate, a main ingredient for the manufacture of RDX. The ammonium nitrate was stored in eleven, above-

* After World War II, there were gradual reductions in the size of the HSAAP until, by the early 1980s, Plant A comprised about 120 acres and Plant B about 5,900 acres.

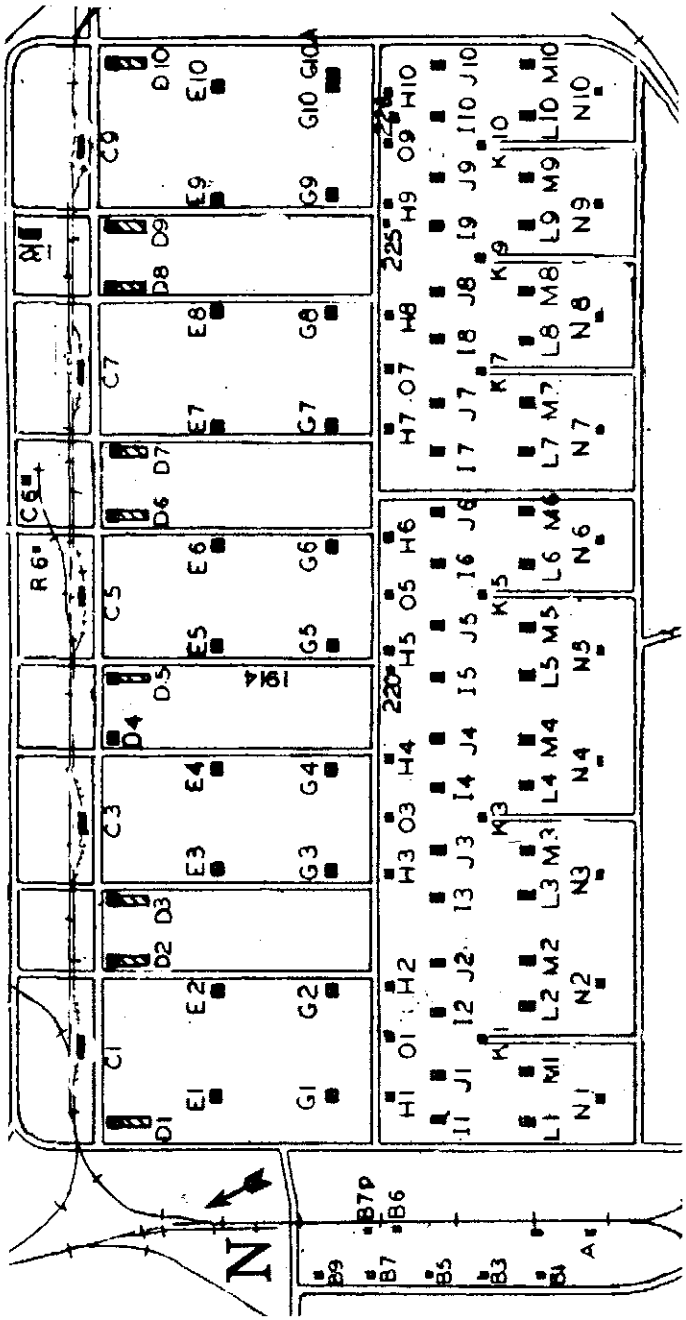

Figure 4: Building location plan of RDX-and-Composition-B manufacturing lines. (Source: Drawing No 7651-212/1226.03, unpublished, prepared by Holston Defense Corporation, 1970, revised 1976, HSAAP Archives.)

Figure 5: Building 1 (Plant B) served as post headquarters for the Holston Army Ammunition Plant until the construction of a new main administration building in 1980. The structure is now used as office space by the naval reserve. (Source: Field inventory photograph, 1983, Jeffrey A. Hess, MacDonald and Mack Partnership.)

ground, Richmond magazines (Buildings b-Y1-Y11). The sixth, and last, major area of Plant B was an extensive storage facility for high explosives. Separated from the rest of Plant B by the Holston River, and located about two miles southwest of the manufacturing area, this facility contained 130 earth-sheltered, Corbetta-type "beehive" magazines (Buildings b-21-150) (Figure 6).[15]

In terms of overall architectural design, the HSAAP reflected both its general industrial function and the no-frills speed of its construction. Almost all the buildings were utilitarian in style without pretense to ornamentation. Perhaps the most striking aspect of the installation was the widespread use of brick, which was generally considered too costly for wartime, munitions-plant construction:

> A reinforced-concrete frame and brick wall design was adopted for most of the heavy manufacturing buildings and for the steam plants, primarily to save steel. Several of these buildings might have been built of all concrete, but lumber was exceedingly scarce and brick was used to save not only steel but form lumber. Brick was available in ample quantities for immediate delivery from a plant near Kingsport. An adequate number of capable bricklayers also was available, making cost of brick construction not excessive as compared to frame construction. Consequently, many buildings that normally would have been of frame construction were built of brick, including the permanent administration buildings and the staff residences.[16]

Since the installation's manufacturing buildings were designed by the Tennessee Eastman Corporation, it is not surprising that they closely resembled the company's factory buildings in Kingsport, which conformed to standard, chemical-plant construction of the 1930s (Figures 7, 8, 9).[17] After the completion of the expansion program in the spring of 1944, the HSAAP experienced little new construction during World War II. The only notable additions before V-J Day were a Nitric-Acid-Ammonium-Nitrate Plant

Figure 6: Magazine 64 at the Plant-B magazine area is typical of the installation's Corbetta magazine facilities. (Source: "Industrial Facilities Inventory," Part 1, Section 7, unpublished, prepared by U. S. Army Corps of Engineers, 1944, HSAAP Archives.)

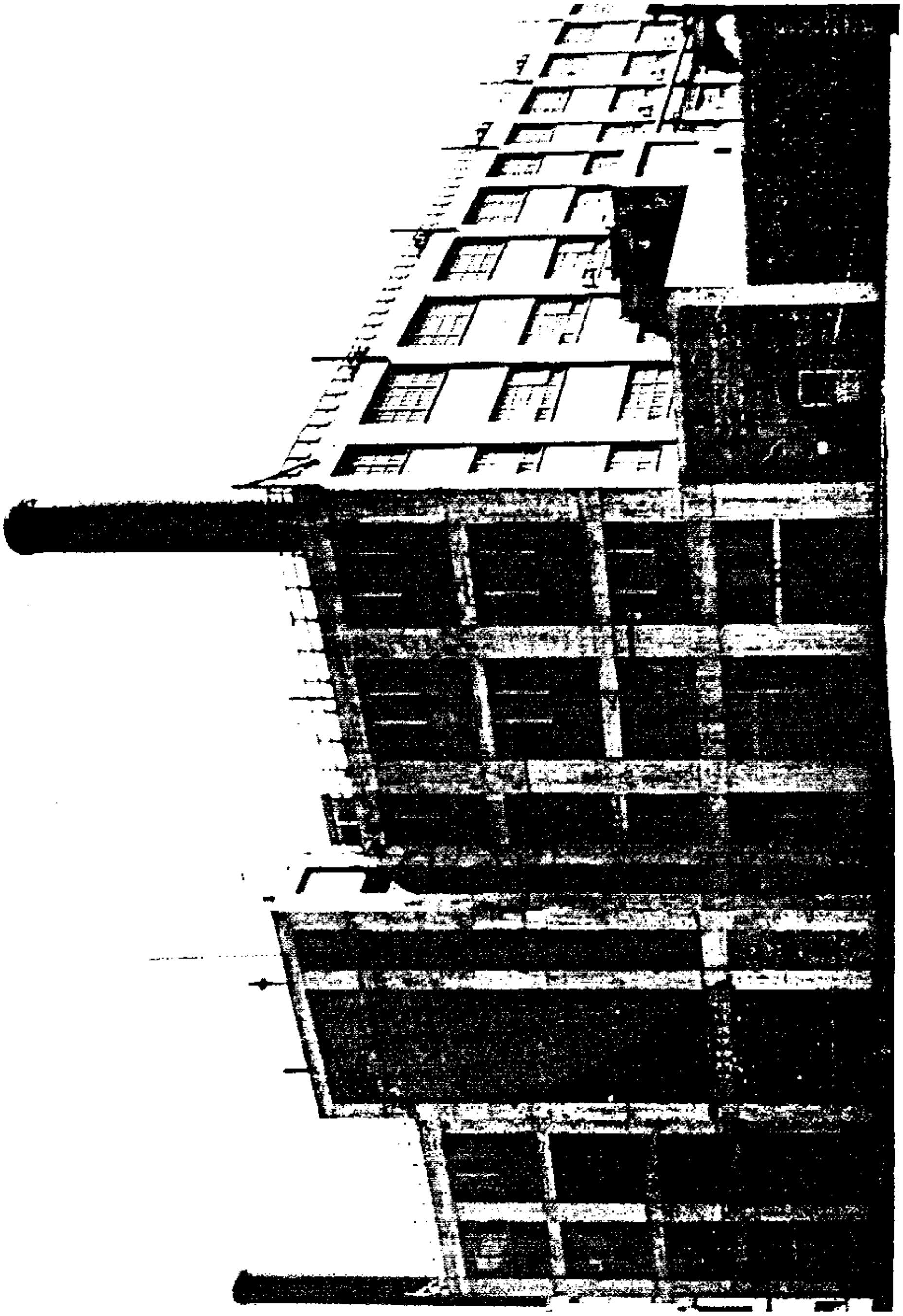

Figure 7: The Acetic-Anhydride Production Plant (Building 7) is typical of the reinforced-concrete-and-brick construction used in Plant-A manufacturing facilities. (Source: "Industrial Facilities Inventory," Part 1, Section 7, unpublished, prepared by U. S. Army Corps of Engineers, 1944, HSAAP Archives.)

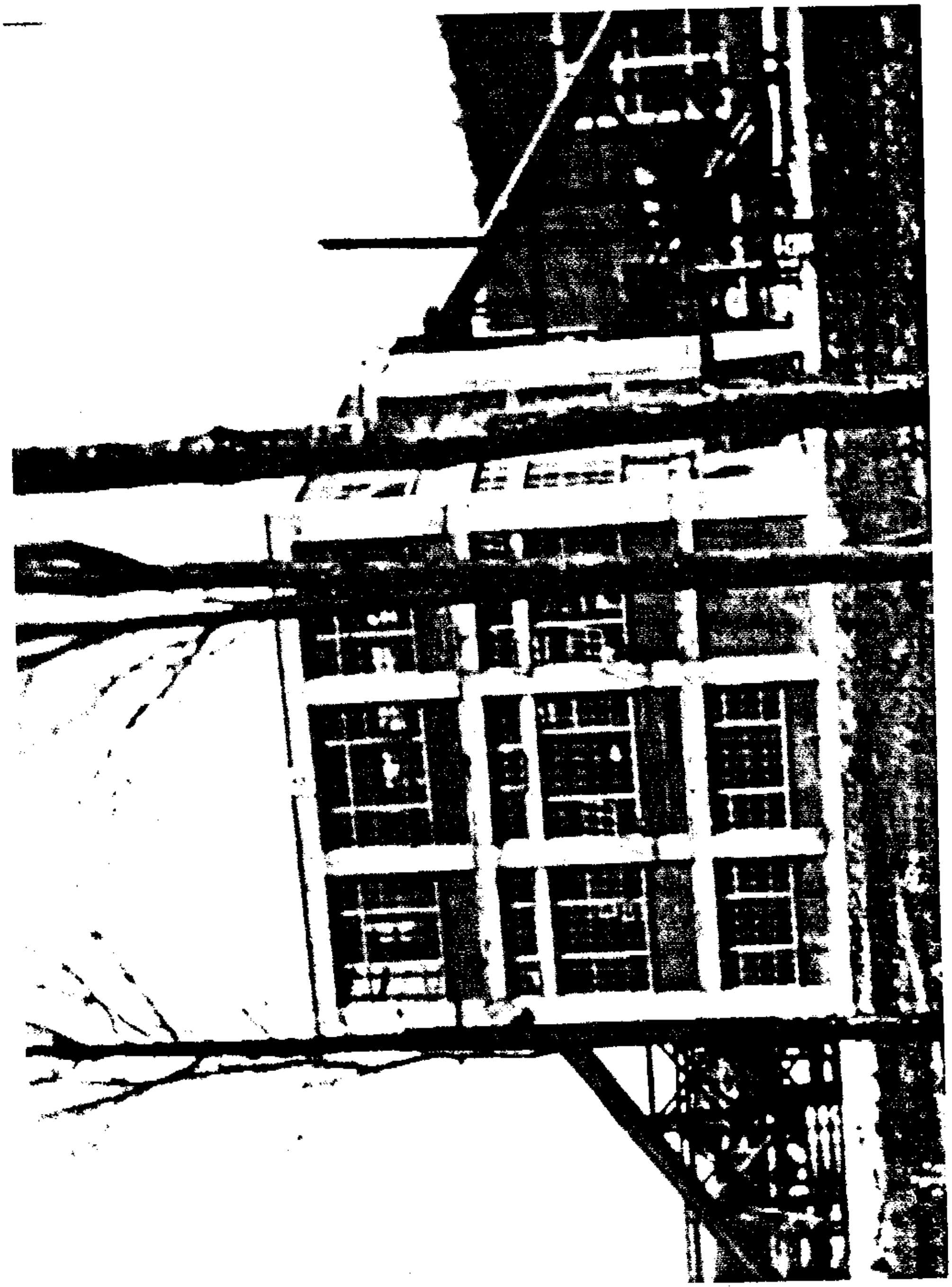

Figure 8: This Recrystallization Building (G4) is typical of the reinforced-concrete-and-brick construction used in RDX-manufacturing facilities at Plant B. (Source: "Industrial Facilities Inventory," Part 1, Section 7, unpublished, prepared by U. S. Army Corps of Engineers, 1944, HSAAP Archives.)

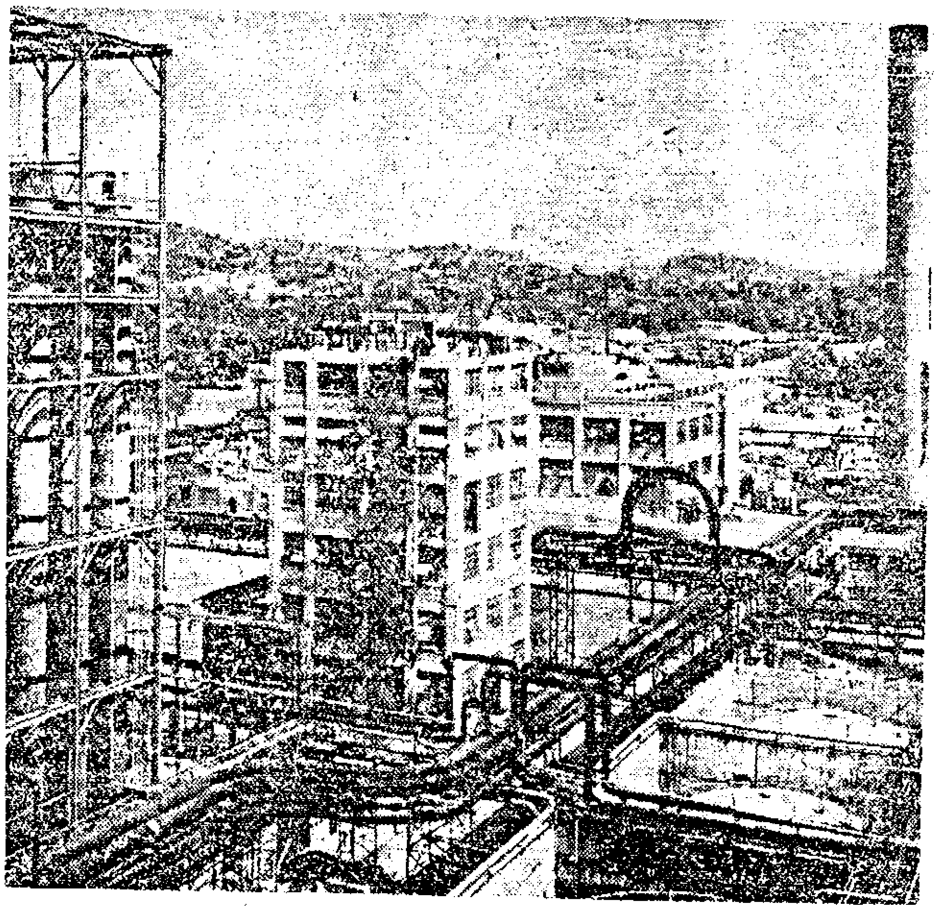

Figure 9: Constructed during the 1930s, Tennessee Eastman Corporation's cellulose-acetate plant in Kingsport served as an architectural and engineering model for many of the production facilities at the Holston Army Ammunition Plant. (Source: Kingsport News, April 9, 1951.)

(Building b-330) in the summer of 1944, and a Magnesium-Nitrate-Nitric-Acid Concentrating Plant (Building b-303-B) in the summer of 1945. Both facilities were located in the acid area of Plant B and conformed to the prevailing utilitarian-industrial architectural style.[18]

Technology

In terms of military technology, the HSAAP is best known for its contributions to the manufacture of RDX during World War II. But the installation was also responsible for manufacturing a number of its own raw materials, which involved it in a number of subsidiary technologies. At the HSAAP, four principal ingredients went into the production of RDX: acetic anhydride, nitric acid, ammonium nitrate, and hexamine. Of these materials, the HSAAP manufactured the first three. We will consider each in turn.

In one way or another, all of the industrial buildings at Plant A were associated with the production of acetic anhydride.[19] By the early 1940s, the most common method for producing this chemical was to dehydrate glacial, or concentrated, acetic acid.[20] This method was well suited for the HSAAP because the RDX-production lines at Plant B released, as a by-product, substantial quantities of dilute acetic acid that could serve as the starting point for acetic-anhydride manufacture. The weak acid from Plant B was shipped to Plant A in tank cars over the inter-plant railroad; it was then delivered to Building a-2 for concentration into glacial acetic.

Although dilute acetic acid could have been concentrated by simple distillation, the heat requirements were too prohibitive for large-scale industrial use. A more feasible method used azeotropic distillation, which was pioneered by British chemists in the 1920s and adopted, with modifications, by the Tennessee Eastman Corporation for its cellulose-acetate plant in Kingsport during the 1930s. Briefly, azeotropic distillation employed an "entraining" liquid that was added to the dilute acid in order to "bind" the water into a special compound known as an "azeotrope" that boiled away at a lower temperature than the general acid-water mixture. Because of the differential boiling points, distillation procedures could then be used to remove the water and concentrate the dilute acid. With only minimal loss, the entraining fluid was recovered from the waste water and continuously recycled.[21] The Acid-Concentration Plant (Building a-2) employed the azeotropic process patented by the Tennesse Eastman Corporation. Designed with a daily production capacity of 3.2 million pounds of glacial acetic, the eight-story structure was divided by a firewall into two identical units, each containing four azeotropic stills. The height of the structure was dictated by the height requirements of the distillation equipment.

Since the glacial acetic produced from the Plant-B dilute acid was insufficient to meet the installation's total acetic-anhydride production requirements, the HSAAP also had the capability to manufacture new acetic acid. Until the early 1930s, almost all glacial acetic produced in the United States was by the destructive distillation of wood. In 1935, however, the Tennessee Eastman Corporation began experimenting with a new British procedure for producing acetic acid by catalytic methods from ethyl alcohol. This procedure was the one adopted at the HSAAP. A Tennessee Eastman spokesman described the process as follows:

> Ethyl alcohol is shipped in tank cars from the Baton Rouge alcohol plant of Esso Standard. The 190-proof alcohol is pumped to storage tanks and then is sent to dehydrogenation units. The dehydrogenation results from the action of a catalyst. The reaction in the dehydrogenation units causes 2 atoms of hydrogen to be liberated, leaving acetaldehyde in vapor form. The vapor is condensed by refrigeration and the resulting liquid passed to an oxidizing tank. When air is blown through the acetaldehyde in the presence of a catalyst, acetic acid is formed and the free nitrogen is removed. The nitrogen is piped off and the acetic acid is condensed. This acid is subsequently concentrated into glacial grade.[22]

At the HSAAP new acetic-acid manufacturing took place in a Catalyst Building (Building a-4), which housed dehydrogenation units, and an Acetic-Acid Production Plant (Building a-3), which contained oxidizing equipment. The new acid was concentrated into glacial grade at the Acetic-Acid Concentration Plant (Building a-2) by the previously described azeotropic method. In terms of total output, the new-acid operation was designed with a daily production capacity of 200,000 pounds of glacial acetic.

Production of glacial acetic acid was the first step in the manufacture of acetic anhydride. In converting acid into anhydride, the HSAAP adopted a system based upon well established industrial processes used by the Tennessee Eastman Corporation at its Kingsport plant. Briefly, this method entailed heating glacial acetic acid in the presence of a catalyst so that it "cracked," or decomposed, into water vapor and a colorless gas called ketene. Next, the ketene was "scrubbed" with fresh glacial acetic acid to form a crude mixture of acetic anhydride and dilute acetic acid. This crude solution was then refined and separated into pure anhydride and glacial acetic by repeated distillation in a rectifying column.[23]

The anhydride operation focused on three principal structures: Buildings a-7 and a-20 prepared the crude anhydride solution, and Building a-6 refined it. In terms of basic equipment, Building a-7 contained thirty-two gas-fired cracking furnaces and sixteen scrubbing trains; Building a-20 housed sixteen gas-fired furnaces and eight scrubbing trains; and Building a-6 had nine rectifying columns.[24] Since the Kingsport area had no natural-gas facilities, the cracking furnaces at Buildings a-7 and a-20 were fueled by a Producer-Gas Plant (Building a-10), which converted bituminous coal and steam into synthetic gas.[25] The industrial system at Plant A was designed with a daily production capacity of 1.6 million pounds of anhydride. After production, the chemical was pumped into storage tanks, and eventually transported in tank cars over the inter-plant railroad to Plant B.

Acetic anhydride was only the first of three RDX ingredients manufactured at the HSAAP. The second principal raw material was nitric acid, which was produced at the "acid area" of Plant B. The production system, designed by the Hercules Powder Co., embodied a standard technology developed by E. I. du Pont de Nemours & Co. in the mid-1920s. In the du Pont process, liquid ammonia was vaporized and mixed with heated compressed air in the presence of a platinum catalyst to form nitrogen oxides. The nitrogen compounds were then further oxidized with air and fed into an absorption tower, where they combined with water to form 60% nitric acid. At the HSAAP, air compressors in Building b-300 supplied the pressurized air required by the du Pont process and the oxidation-and-absorption process took place in Building b-302.[26]

Like most industrial uses of nitric acid, the manufacture of RDX required an almost pure grade of the ingredient. To achieve this level of purity, the HSAAP used the time-honored technique of concentrating the 60% nitric acid by dehydrating it with sulphuric acid. This process occurred in dehydration towers at Building b-303. The spent sulfuric acid, now diluted with water, was collected in concentrator drums at Building a-308, where it, in turn, was dehydrated by blasts of hot gases from oil-fired furnaces. The re-concentrated sulfuric acid was then ready to be recycled in the nitric-acid operation.[27]

The third, and last, RDX ingredient produced at the HSAAP was ammonium nitrate. Until the summer of 1944, the installation purchased its ammonium nitrate from the Kansas Ordnance Works and the Wolf Creek Ordnance Works, where it was synthesized primarily for use in making the TNT-based explosive Amatol. In the spring of 1944, however, the Ordnance Department determined that "a savings of approximately $5,000.00 per day can be effected" if the HSAAP were to manufacture the material on its own premises. The new Ammonium-Nitrate Production Plant (Building b-330) was constructed and in operation by August 1944. The operation employed a standard procedure of mixing ammonia and strong nitric acid in continuous reactors to produce an ammonium-nitrate solution. The only drawback to the operation was that the HSAAP could not manufacture enough nitric acid to meet the production requirements of both RDX and ammonium nitrate. This deficit was initially made up by nitric-acid shipments from other ordnance works that had excess capacity. In 1945, however, increased demands for TNT created a general nitric-acid shortage in the munitions industry, and the HSAAP ammonium-nitrate plant was forced to shut down.[28]

Although the HSAAP made no major technological changes in its production of RDX ingredients during World War II, the installation did host some important experimental work in the area of nitric-acid concentration. After considerable developmental work, the Tennessee Eastman Corporation received government authorization to proceed with a pilot project for a revolutionary new method of dehydrating nitric acid by means of magnesium nitrate. The pilot plant (Building b-303-B) was built and in operation by March 1945. An Ordnance Department memorandum briefly describes the new process as follows:

> Weak Nitric Acid is to be fed continuously into a continuous column below a rectifying section with hot liquid (95%) Magnesium Nitrate being added at a somewhat higher point. Strong nitric acid is distilled from the top of the column through a bleacher pot to storage. At the base of the column, the Magnesium Nitrate-water solution would flow to a base heater where the water would be driven off by high pressure coil steam. Part of the water so obtained would be returned to the column for reboiling heat and the remainder discharged for pre-heating feed and finally for use as [Ammonium-Oxidation Plant] feed water. The residue of the concentrated Magnesium Nitrate will be pumped continuously from the base heater through a steam-jacketed line to a point in the tower above the weak Nitric feed.[29]

Although this pilot project never moved beyond the experimental phase, it laid the groundwork for the development, during the 1950s, of the magnesium-nitrate dehydrating tower, or "maggie unit," which would offer the nitric-acid industry an alternative to the conventional sulfuric-acid technique of concentrating weak nitric.[30]

In planning raw-material production at the HSAAP, the Tennessee Eastman Corporation relied on well established industrial processes. But the preparation of RDX by the Bachmann method was quite another matter. When Tennessee Eastman first began its work on a pilot plant for RDX in early 1942, the Bachmann method was a laboratory procedure rather than a mass-production technique. In its basic outline, the method called for both dry and liquid ingredients that were reacted in a two-stage batch process with an intermediate drying period. During its experimental work, Tennessee Eastman streamlined this procedure by means of two important innovations. First, all ingredients were transformed into concurrent liquid feeds that were reacted in a one-stage, continuous nitrator. Second, a production system was devised whereby the RDX was transferred from one processing building to another in slurry form through the use of centrifugal pumps. As a result of these innovations, the Bachmann method became a continuous manufacturing process, with raw materials entering at one end of a production line, and RDX rolling off at the other.[31]

Tennessee Eastman also improved on the standard British method of combining RDX and TNT into Composition B. As one observer noted, "The British procedure for making Composition B was to melt TNT in a heated kettle, shovel in wet RDX and stir until the water evaporated. The molten mix was then poured into trays something like biscuit pans where it cooled and solidified. With only a few pounds per tray, this was a real labor hog. Besides, the workers were constantly exposed to poisonous TNT fumes."[32] To speed up the final casting-and-cooling process, Tennessee Eastman devised a continuous pelleting procedure that used "an agitated casting pot with multiple holes in the bottom"[33] to extrude the warm Composition B mixture onto a cooling conveyor belt (Figures 10, 11). "The process was simple, ingenious and safe. It eliminated the TNT fume problem and reduced labor by a very large factor."[34]

In its final design, the Plant-B manufacturing area was organized into ten nearly identical, parallel production lines, each containing ten principal buildings (Figure 12). The first five structures in a line (Buildings C, D, E, G, H) manufactured RDX; the last five (Buildings I, J, L, M, N) Composition B. From start to finish, production went as follows:

> "C" Building serve[s] as [a] collection point for explosives' starting materials . . . [These] raw materials, including nitric acid-ammonium nitrate solution, hexamine-acetic acid solution, and acetic anhydride, are pumped to the "D" Building. They are fed into a reactor [where] a centifugal pump . . . serves as a quick mixing device. The vigorous, rapid reaction releases large quantities of heat. To control temperature, the pump discharges directly into water-jacketed pipe heat exchanger loops. As the solution circulates, nitrolysis takes place. Reactants return to the reactor and overflow into the age (or hold up) tank, in which the reaction is completed. Temperature is controlled with filtered water. The product overflows into a series of simmer tanks where linear nitramines and other undesirable by-products are destroyed. The crude RDX slurry is cooled, diluted with water, and pumped in to the "E" Building [where] spent acid is removed and the product washed with water. Washed explosive slurry from the "E" Building is pumped to the "G" or Recrystallization Building. The non-uniform, crude crystals of RDX contain occluded acid. By partially dissolving the RDX in either acetone or cyclohexanone, the acid is removed [and] crystals are enlarged . . . . After simmering, the slurry is dropped by gravity through a screen to remove any foreign matter that would sensitize the RDX. The filtered solution is distilled to gradually remove the solvent (which is recovered) and to reprecipitate the RDX under conditions which control particle size distribution . . . . RDX is [then] pumped to the "H" or Dewatering Building. After being pumped in a water slurry into receiving tanks, RDX is dropped to stainless steel nutches [i.e., containers]. Perforated stainless steel probes, covered with a cotton filter cloth, remove the water by vacuum filtration [Figure 13]. . . . RDX in final form is taken to the Incorporation Building via wheeling ramps. There are four

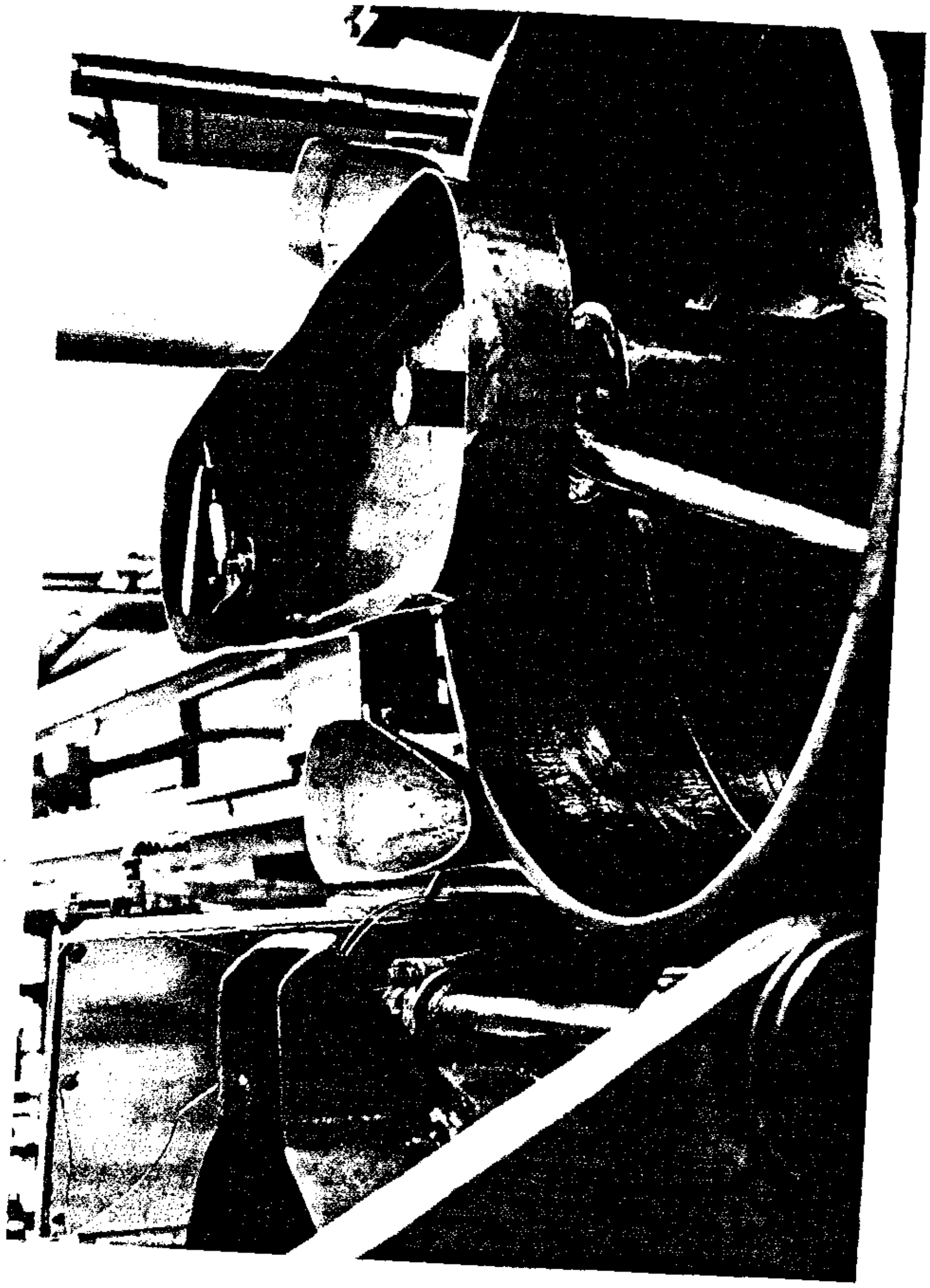

Figure 10: This incorporation kettle in Building J10 at Plant B blends and extrudes TNT and RDX to form strips of Composition B. (Source: Field inventory photograph, 1983, Jeffrey A. Hess, MacDonald and Mack Partnership.)

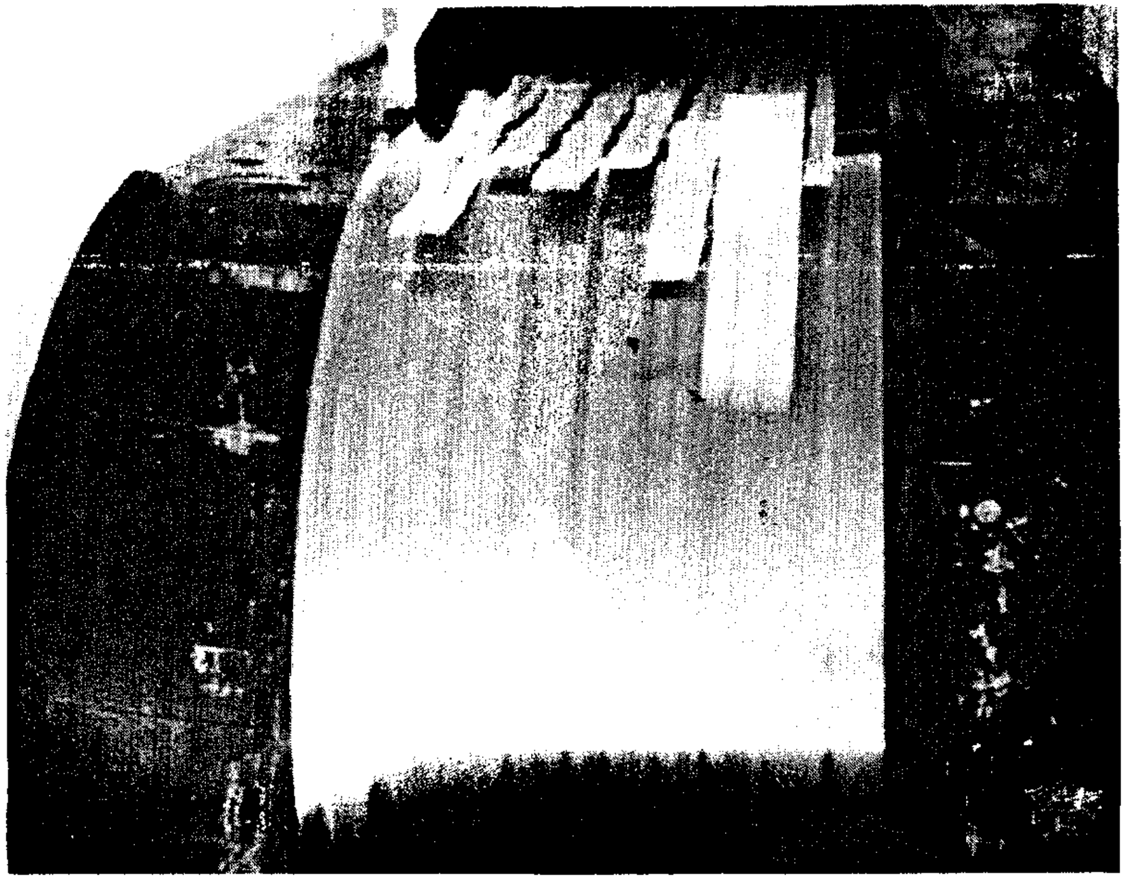

Figure 11: Extruded Composition B rolling off a conveyorized casting belt in one of the Incorporation Buildings at Plant B. (Source: Holston Army Ammunition Plant (No pl.: Holston Defense Corporation, c. 1975.)

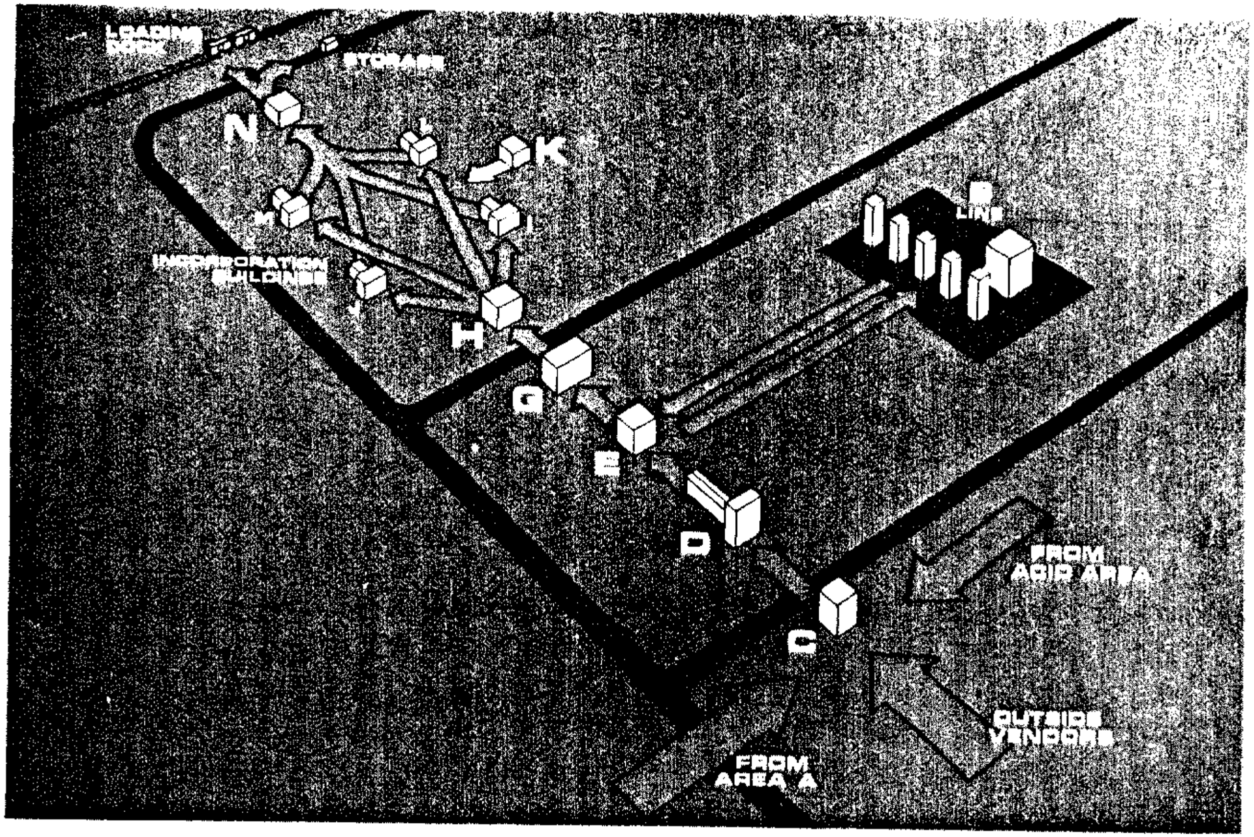

Figure 12: Typical layout of an RDX-and-Composition-B Manufacturing Line at Plant B. (Source: <u>Holston Army Ammunition Plant</u> (No pl.: Holston Defense Corporation, c. 1975.)

B Line:	Primary Distillation Buildings	Building H:	Dewatering Building
Building C:	Collection Building	Buildings I, J, L, M:	Incorporation Buildings
Building D:	Nitration Building	Building K:	TNT-Opening Building
Building E:	Washing Building	Building O:	Laboratory
Building G:	Recrystallization Building	Building N:	Packaging Building

Figure 13: In the Dewatering Buildings (H Buildings) at Plant B, perforated stainless steel probes covered with cotton filter cloth remove water from the RDX slurry by means of vacuum filtration. (Source: Holston Army Ammunition Plant (No pl.: Holston Defense Corporation, c. 1975.)

> Incorporation Buildings [,I, J, L, and M,] in each line. Melted TNT is siphoned into the incorporation kettle. Wet RDX is shoveled from the nutsche into the agitated kettle using a nonmetallic shovel. After water is descanted from the surface, the batch is heated until all moisture is removed. Melted wax is added as a desensitizer. The molten Composition B flows from a casting pot onto a casting belt. Composition B is [then] delivered to the "N" or Packaging Building where it is boxed. After it is boxed and weighed, the product may go direcly to rail docks, or to magazine storage.[35]

The HSAAP's first production line for RDX and Composition B went into operation in April 1943, and by the end of that year, all ten lines were in production. At peak performance, the installation manufactured 40 million pounds of Composition B per month, and its total wartime output reached nearly one billion pounds. The HSAAP continued to operate at maximum levels until July 1945, when nine of its ten explosives lines were deactivated. Complete shutdown occurred immediately after V-J Day. On November 1, 1945, the HSAAP was designated a "standby" facility, and two weeks later, the Tennessee Eastman Corporation turned the installation over to the Ordnance Department for continued maintenance and supervision.[36]

KOREAN WAR

In April 1949, the HSAAP was removed from standby status and reactivated as a production facility under the contract-supervision of the Holston Defense Corporation, a newly formed subsidiary of the Eastman Kodak Company of Rochester, New York. Initially, production activities focused on the reworking of surplus stocks of Composition B, which involved the use of one manufacturing line. But as the Korean War got underway, most of the installation's facilities at Plants A and B were mobilized for new production. During 1951-1954, a total of eight manufacturing lines were rehabilitated, and in August 1953, production reached a monthly peak of 15.2 million pounds of Composition B. Following the cessation of hostilities, the HSAAP quickly reverted to a one-line operation with monthly output stabilizing at about one-half milion pounds of explosives from 1958 to 1961.[37]

Construction

During the 1950s, the HSAAP witnessed the construction of approximately one dozen new buildings that closely conformed to the utilitarian-industrial architectural style employed during World War II. Plant A received two small storage facilities (Buildings a-TA613, a-TA636), a Carpenter Shop (Buildings a-TA505), and a Sewage Pumphouse (Building a-29). New construction at Plant B included a substantial General Purpose Warehouse (Building b-117), an Auto Paint Shop (Building b-116), a Paint Storehouse (Building b-118), and five nitric-acid production facilities (Buildings b-302-B, b-303-B, b-303-C, b-303-D, b-308-B). Also, above-ground pipelines were constructed between Plant A and B for the transport of acetic acid and acetic anhydride, thus eliminating the previous use of tank cars over the inter-plant railroad. In 1957, the D Building in Production Line 4 at Plant B was severely damaged by fire, and the structure was subsequently demolished.[38]

Technology

Although most of the HSAAP's production lines for RDX and Composition B were modified during rehabilitation for the Korean War, the basic manufacturing processes developed during World War II continued to govern the operation. The most significant change occured at Production Line 4, which was converted to the manufacture of a new high explosive known as HMX. Nearly identical in chemical structure to RDX, this new nitramine compound is characterized by a higher melting point, which led to its designation as "High Melt Explosive," or HMX. HMX is always produced in minute amounts during the manufacture of RDX by the Bachmann method, and it was first isolated and identified by Bachmann during his experimental work on RDX in 1941-1942. Although HMX was found highly suitable for plastic explosives, it proved too difficult and expensive to manufacture during World War II, and only a pilot production run of 25,000 pounds was attempted at the HSAAP before V-J Day. In 1952, however, the HSAAP once again took up the production of HMX, and gradually developed a successful batch operation at Production Line 4 that was quite similar to the general Bachmann method used for RDX manufacture. When the D building for HMX production was destroyed by fire in 1957, new equipment was installed in the D Building of Production Line 5.[39]

Other technological changes also occurred at the acid area of Plant B. In 1952 a magnesium nitrate facility for concentrating nitric acid was perfected at Building b-303-B, using the general method pioneered at the HSAAP during World War II. Since nitric-acid production had been a bottleneck at the installation during the 1940s, the HSAAP also was equipped with two new conventional Nitric-Acid Concentrating Plants (Buildings b-303-C, b-303-D) in 1951 and 1954, a new Ammonium Oxidation Plant (Building b-302-B) in 1954, and a conventional Sulfuric-Acid Concentrating Plant (Building b-308-B) in 1958. Although the new Ammonium

Oxidation Plant (Building b-302-B) employed the standard du Pont pressure process, it differed from the World-War-II vintage plant (Building b-302) by housing its own air compressors, and by employing a newly developed power-recovery system that harnessed the energy of emitted stack gases to drive the air-compressor machinery.[40]

VIETNAM WAR

Although the HSAAP remained in operation after the Korean War, production was generally restricted to one manufacturing line and rarely exceeded one-half million pounds of Composition B per month. As a result of the Berlin and Cuban crises of the early 1960s, the installation's monthly output increased to about two million pounds, but large-scale production did not resume until the Vietnam buildup of the mid-1960s. During 1965-1966, the government appropriated about $40 million to modernize the HSAAP's production equipment and support facilities, and to rehabililtate Production Lines 9 and 10, which had not seen use since World War II. By December 1968, all ten lines were in service, with a combined monthly production of about 33 million pounds of Composition B, which nearly equalled the World-War-II record. With the conclusion of the Vietnam War in 1973, the installation's output of Composition B rapidly declined to about two million pounds per month in early 1976. Throughout the Vietnam era, the Holston Defense Corporation continued to serve as contractor-operator.[41]

Construction

During the 1960s and early 1970s, the HSAAP witnessed the construction of approximately 70 buildings, of which the vast majority served maintenance, storage, and utility purposes. All of the new buildings conformed to the installation's prevailing utilitarian-industrial architectural style. Quonset construction was frequently employed. With the exception of two maintenance shops (Buildings a-31, a-34) erected at Plant A in 1968 and 1973, new construction was restricted to Plant B, with its greatest concentration in the Shop Area. The major facilities completed during this period were a Sewage Treatment Plant (Building b-216) in 1960, two Magnesium-Nitrate Facilities (Buildings b-304, b-334) in 1965 and 1966, a Water Filtration Plant (Building b-221) in 1966, two large General Purpose Warehouses (Buildings b-140, b-141) in 1968, and a Steam Plant Addition (Building b-222) in 1969, which contained three gas-fired boilers.[42]

Technology

Although the HSAAP did not incorporate any radical new procedures for manufacturing RDX or Composition B during the Vietnam War, it did adopt several equipment modifications that resulted in a continuous supply of ammonium-nitrate solution and hexamine-acetic-acid solution from the C Buildings, continuous aging and simmering in the D Buildings (which improved D-Building production by 50%), and improved filtration in the H Buildings. At the same time, the HSAAP completely converted its nitric-acid concentrating procedures to the magnesium-nitrate method, erecting four "maggie units" in Building a-304 in 1965, and an additional four in Building a-334 in 1966. The installation of the maggie units was accompanied by the demolition of the World-War-II-vintage Nitric-Acid Concentrating Plant (Building b-303) and the Sulfuric-Acid Concentrating Plant (Building b-308). During the Vietnam War the HSAAP began purchasing glacial acetic acid instead of manufacturing it at Plant A. This led to the closing down of the Acetic-Acid Production Plant (Building a-3) and the Catalyst Building (Building a-4). The Acetic Acid Production Plant (Building a-3) was demolished in 1982.[43]

RECENT DEVELOPMENTS, 1973-1983

Under the continued contract-supervision of the Holston Defense Corporation, the HSAAP remained in operation throughout the 1970s and early 1980s. Although monthly production of Composition B gradually tapered off to less than a million pounds per month, this decline in production was partially offset by increased demand for "special-order" propellants and explosives using RDX and HMX. Between 1974 and 1983, the HSAAP also produced about one-quarter of a million pounds of HMX per month for the Navy's Trident Program.[44]

Construction

With the conclusion of the Vietnam War, the Department of Defense initiated a ten-year modernization program for its munitions facilities, including the HSAAP. This program entailed the replacement of outmoded structures with permanent modern facilities, and the implementation of pollution-abatement measures. Between 1973 and 1983, approximately thirty new buildings were constructed at the HSAAP for administrative, manufacturing, maintenance, storage, and utility purposes. Almost all of the new construction occurred at Plant B, and it generally conformed to the installation's prevailing utilitarian-industrial architectural style. The most prominent of the additions was a new General Administration Building, completed in 1980 at Plant B. Constructed of pre-cast-panel exposed aggregate, the building was designed in a modern corporate style. Despite the modernization program of the 1970s, the HSAAP still strongly reflects its World-War-II origin. As of 1983, the installation contains approximately 465 buildings, and more than three-quarters of these structures date from the original construction period.[45]

Technology

During the 1970s, most of the technological developments at the HSAAP were geared to bringing the installation into compliance with federal clean air and water regulations. Completed measures included the construction of a holding pond at Plant A for acetic-anhydride production wastes, the installation of electrostatic precipitators for the coal-fired furnaces at the steam plants (Buildings a-8, b-200), and the erection of a new Ammonium Oxidation Plant (Building b-337) with "an extra large absorption tower to reduce nitrogen oxide fumes to acceptable standards."[46]

NOTES

1. James Phinney Baxter, III, Scientists Against Time (Boston: Little, Brown and Company, 1946), pp. 42-46; "Construction Speeded Output of 'RDX'" Engineering News-Record, 96 (July 25, 1946), 64.

2. On the formation of the NDRC, see Baxter,pp. 14-25, 119-123, 451.

3. The British work with RDX during the 1930s is described in W. H. Simmons, "The Manufacture of R.D.X. in Great Britain," Industrial Chemist, 24 (July, 1948), 429-430; R. C. Burton, "The Origin of Holston Army Ammunition Plant," Speech before Rotary Club of Kingsport, Tenn., Sept. 10, 1975 (Kingsport: n. pub., 1975), n.p., in Palmer Room, Kingsport Public Library. On the use of RDX in naval ordnance, see Buford Rowland and William B. Boyd, U.S. Navy Bureau of Ordnance in World War II (Washington, D.C.: U.S. Government Printing Office, n.d.), pp. 204-207; Constance McLaughlin Green and others, The Ordnance Department: Planning Munitions For War (Washington, D.C: Office of the Chief of Military History, Department of the Army, 1955), p. 463.

4. The use of the Woolwich method at the Bridgewater plant is discussed in Simmons, "The Manufacture of R.D.X. in Great Britain," Industrial Chemist, 24 (July 1948), (August 1948), (September 1948), 429-432, 530-544, 593-601. On the method's nitric-acid requirements, Simmons writes: "One of the most striking features of the Woolwich process for the manufacture of R.D.X. is the size of the acid plant necessary. . . . It had been learnt by experience that the production of 1 ton of R.D.X. required the addition of 0.86 tons hexamine to 11 tons of concentrated nitric acid. Of this 11 tons about 5 tons could be recovered as weak acid . . . and rather more than 4 tons by absorption of the nitrous fume produced in the process. Allowing reasonable process losses, it was clear that for each ton of R.D.X. there would be about 9 tons of weak nitric to reconcentrate, and rather more than 2 tons of new strong nitric acid to reduce" (p. 430). The initial involvement of the NRDC with RDX research is discussed in Baxter, pp. 255-256.

5. Bachmann's initial response to the RDX project is noted in Baxter, p. 256. The first published description of the Bachmann method is found in W.E. Bachmann and John C. Seehan, "A New Method of Preparing the High Explosive RDX," Journal of American Chemical Society, 71 (May 1949), 1842-1845. The method's pros and cons are analyzed in Burton, n.p.

6. On Tennessee Eastman's production of cellulose acetate, see "Eastman Corp. Defies Slump," Knoxville Journal, June 4, 1933; "Chemical Wonderland," Oilways, 14 (June 1948), 1-5. The acetic-acid recovery problems involved in the manufacture of cellulose acetate are discussed in Alfred George Lipscomb, Cellulose Acetate (London: Ernest Benn Limited, 1933), pp. 77-101. For Tennessee Eastman's pilot-project work, see Burton, n.p. It should be noted that the HSAAP was not the first RDX plant built in the United States. The first plant was the Wabash River Ordnance Works, a Woolwich-type facility constructed at Newport, Indiana during 1941-1943. Boasting the world's largest nitric-acid works, the Wabash River plant accounted for about one-tenth of American RDX production during World War II; its RDX lines were completely dismantled in the 1970s. See Baxter, p. 257.; William Voight, Jr., "The Ordnance Organization in World War II," pp. 312-315, unpublished report, 1945, on microfiche,

in AMCCOM Historical Office, Rock Island Arsenal; C.H. Carter, Jr. and others, "History of the Powder and Explosives Section, March 1943 to September 1945," unpublished report prepared for Ammunition Division, Office of the Chief of Ordnance, 1945, pp. 9-11, Appendix IV-33, on microfiche, AMCCOM Historical Office; "Holston Army Ammunition Plant, Historical Monograph Covering the Period 1 July 1942 Through 30 June 1963," unpublished report prepared by Holston Defense Corporation, 1963, p. 22, in Holston Defense Corporation Archives, HSAAP.

7. Voight, pp. 132-133; Burton, n.p.

8. Lenore Fine and Jesse A. Remington, The Corps of Engineers: Construction in the United States (Washington, D.C.: Office of the Chief of Military History, United States Army, 1972) pp. 134-137.

9. "It's a Long Way from a Pasture to Ammo Plant," Kingsport News, November 14, 1968. The thirty-eight buildings within the boundaries of the HSAAP as of October 1944 are inventoried in "Industrial Facilities Inventory, Holston Ordnance Works," Plant B, Part I, Section 9, n.p.; Part II, Section 4, n.p., unpublished report prepared by U.S. Army Corps of Engineers, Office of the District Engineer, Knoxville, Tenn., 1944, in AMCCOM Historical Office.

10. Harry Englander, Building Holston Ordnance Works (New York: Fraser-Brace Engineering Co., Inc. 1946), p. 15, in Holston Defense Corporation Archives, HSAAP. See also Fine and Remington, p. 517.

11. The description of the various contracts is from "Construction Speeded Output of 'RDX,'" 65. Fraser-Brace's work on the Weldon Springs plant is noted in Englander, p. 19. On Charles T. Main, Inc. and Camp Edwards, see Fine and Remington, p. 211.

12. Fine and Remington, p. 595.

13. Englander, p. 47.

14. "Industrial Facilities Inventory," Plant A, Part I, Section 11; Part II, Section 4, n.p.; Plant B, Part I, Section 11, n.p. Also see the "Plot Plan for Plant A, in Plant A, Part I, Section 5, n.p. It should be noted that Building a-20 is incorrectly identified as an "acid-making" plant in the principal inventory (Plant A, Part II, Section 4, Sheet 1). It is correctly identified as an Acetic-Anhydride Production Plant in the "equipment layout" flow charts (Part III, Section 1, n.p.).

15. "Industrial Facilities Inventory," Plant B, Part II, Section 4, n.pl.; also see the "Plot Plant" for the various areas of Plant B in Plant B, Part 1, Section 5, n.p.

16. "Construction Speeded Output of 'RDX'" 67. Immediately after Pearl Harbor the Army Ordnance Department laid down strict rules for future munitions plant construction: "There is no excuse for masonry structures . . . where a light frame structure will serve the purpose.

There is no excuse for the use of expensive materials where less costly ones will serve the purpose for the period of time for which the construction is being provided." By the spring of 1942, however, the nation was experiencing a critical lumber shortage which prompted Ordnance construction supervisors to permit the substitution of brick for wood "where the difference in cost and completion time was not excessive." On this matter of building materials, see Fine and Remington, pp. 517, 547. The shortage of structural steel for wartime construction created some special problems at the HSAAP, which required several railroad bridges across the Holston River. Since new steel was unavailable for these structures, Fraser-Brace resorted to salvage operations, dismantling and moving two abandoned bridges originally constructed for the Southern Railway Co. at Lynchburg, Virginia in 1895 and 1903. The two bridges were similar Warren-truss structures. After dismantling and moving, the old bridge-work was reassembled at the HSAAP into three railroad crossings over the Holston River: "the three-span Holston Bridge No. 1, the two-span Slough Bridge, and the four-span Clouds Bend Bridge." See Englander, p. 40; "Ordnance Plant Bridge Built of Old Trusses," Engineering News-Record, 93 (June 17, 1943), 89-91.

17. The original design of the Tennessee Eastman Corporation plant in Kingsport is shown in a photograph of the recently completed facility in "Eastman Corp. Defies Slump," Knoxville Journal, June 4, 1933.

18. On the construction of the Nitric-Acid-Ammonium-Nitrate Plant, see "Industrial Facilities Inventory," Plant B, Addendum, Part II, Section 4, Sheet 3, n.p.; Carter, pp. 47-48, Appendix IV-49, 50, 51. On the construction of the magnesium-nitrate facility, see "Industrial Facilities Inventory," Plant B, Addendum Part II, Section 4, Sheet 2, n.p.; Carter, p. 49, Appendix IV-60, 61.

19. The discussion of Plant-A industrial facilities relies heavily on information provuded by Henry Hurd, Holston Defense Corporation Superintendent of Organic Acids, and Robert Brewer, Jr., Holston Defense corporation superintendent of Organic Acids, and Robert Brewer, Jr., Holson Defense Corporation Supervisor of Area A Utilities, during on-site interviews on April 13, 1983. Also helpful were "equipment layout" plans for the various buildings in "Industrial Facilities Inventory," Plant A, Part III, Section 1, n.p. Daily production capacities for the various processes are in Plant A, Part II, Section 1, n.p.

20. G. Benson, "New Acetic Anhydride Process," Chemical and Metallurgical Engineering, 47 (March 1940), 150.

21. On the development of the azeotropic distillation of acetic acid, see Lipscomb, pp. 77-88; R. Norris Shreve, Chemical Process Industries (New York: McGraw-Hill Book Company, 1967, 3rd. ed.), pp. 620-621.

22. "Making Acetic Anhydride from Petroleum Ethyl Alcohol," Oilways, 14 (June 1948), 3. Although this article describes the Tennessee Eastman plant in Kingsport, the same technology was used at the HSAAP. The

historical background on acetic-acid manufacture is derived from F. J. Curtis, "Complex Situation Impending in Acetic Acid Manufacture," Chemical and Metallurgical Engineering, 38 (January 1931), 38-39.

23. Lipscomb, pp. 93-98; "Making Acetic Anhydride for Petroleum Ethyl Alcohol," 3.

24. Building a-6 also contained an azeotropic still. The thermal cracking of glacial acetic acid in Buildings a-7 and a-20 was never 100% efficient, and residual amounts of acetic acid were carried over into the ketene-and-water-vapor mixture. The dilute acid was separated from the ketene by condensing trains in Buildings a-7 and a-20, and piped into the azeotropic still in Building a-6, where it was processed into glacial acetic acid. This concentrated acid was then piped back to Buildings a-7 and a-20, where it was used to scrub the ketene.

25. "Producer gas . . . is made by blowing air or a mixture of air and steam through an incandescent fuel bed. The oxygen of the air combines with the carbon in the fuel bed to produce carbon monoxide and some carbon dioxide, while the steam in the entering blast combines with the carbon. . . to produce carbon monoxide and hydrogen. The nitrogen of the air passes through the fuel bed unchanged and appears in the final product . . . . Producer gas from bituminous coal contains several percent of methane and some additional hydrogen, as well as tar vapors, all derived from the volatile matter of the coal"; from Basis W. Waring and John F. Foster, eds., Economics of Fuel Gas from Coal (New York: McGraw-Hill Book Company, Inc., 1950), pp. 13, 4. Easy and cheap to manufacture, producer gas saw widespread industrial use in the United States during the period between the two world wars, especially in areas that were not supplied with natural gas. The system at the HSAAP was designed by the Semet-Solvey Engineering Corporation of New York, a prominent firm in the synthetic-gas equipment field. The HSAAP gas plant was an atmospheric system consisting of twelve fixed-bed producer units equipped with overhead coal feeds. Steam and air were mixed in a saturation column and then fed, in an up-draft arrangment, through the coal bed of each producer. The resulting gas was taken off under vacuum at the top of the producers and sprayed with water to remove pitch and other impurities.

26. The discussion of Plant-B acid-area facilities relies heavily on information provided by Robert Wicker, Holston Defense Corporation Chemical Engineer, during an on-site interview, April 14, 1983. Also helpful were "equipment layout" plans for the various buildings in "Industrial Facilities Inventory," Plant B, Part III, Section 1, n.p. On the duPont Process, see Guy B. Taylor and others, "Manufacture of Nitric Acid by the Oxidation of Ammonia," Industrial and Engineering Chemistry, 23 (August 1, 1931), 860-865; D.J. Newman and L.A. Klein, "Recent Developments in Nitric Acid," Chemical Engineering Progress, 68 (April 1972), 62.

27. The sulfuric-acid reconcentration system in Building b-308 was engineered by the New-York-based Chemical Construction Corporation ("Chemico"), using a design that it had standardized for the industry. The flowchart for the Chemico process found in Shreve (p. 340) applies to the HSAAP system.

28. Details of the HSAAP ammonium-nitrate operation are provided in Carter, p. 48, Appendix IV-49, 50, 51.

29. Carter, Appendix IV-60; see also p. 49 and Appendix IV-61.

30. See "'Maggie' Concentrates Nitric," Chemical and Engineering News, 36 (June 9, 1958), 40-41; "New Process Chops Cost of Concentrating Nitric," Chemical Engineering, 65 (July 28, 1958), 68.

31. On the modificaton of the Bachmann method by the Tennessee Eastman Corporation, see J. T. Bearden, "A Short History of HDC," unpublished, 1970, pp. 4-7, Holston Defense Corporation Archives, HSAAP; Burton, n.p.

32. Burton, n.p.

33. Bearden, p. 9.

34. Burton, n.p.

35. This passage is from Holston Army Ammunition Plant (n. pl.: Holston Defense Corporation, n.d), pp. 11-18. Although the description primarily applies to RDX and Composition B production as of 1983, it also covers the essential features of the World-War-II operation. This judgement is based upon information provided by Jerry Blair, Holston Defense Corporation Superintendent of HMX Products, during an on-site interview, April 12, 1983, and upon "equipment layout" plans for the various production buildings in "Industrial Facilities Inventory," Plant B, Part III, Section 1, n.p. The spent-acid solution removed from the RDX slurry in the E Buildings consisted of nitric acid, acetic acid, and residual amounts of RDX. This solution was pumped to a row of structures (Buildings b-B-1, B-3, B-5, B-7, B-9) bordering the west end of the manufacturing area. There the nitric acid was neutralized with caustic, the RDX residue recovered and pumped back to the E Buildings, and the acetic acid distilled to 60% strength and shipped to Plant A for processing into glacial acetic.

36. "Holston Army Ammunition Plant Historical Monograph," pp. 11-13.

37. Susan S. Pridemore, "Holston Army Ammunition Plant, Unit History, 1943-1967," unpublished report prepared by HSAAP, 1968, p. 5, in HSAAP Administrative Archives; "Holston Army Ammunition Plant Historical Montogaph," p. 17.

38. This assessment of construction activities is derived largely from Holston Army Ammunition Plant Real Property Inventory, computer printout, March 1982, HSAAP Archives. The chemical pipelines had been

planned for the initial construction period, using "a copper pipe line for return of Acetic Acid to Area A from Area B and a steel pipe line for pumping Acetic Anhydride from Area A to Area B. [But] at that time it was impossible to get the necessary copper so arrangments were made to do this work utilizing Acid tank cars, and a railroad was built between the plants"; see Carter, Appendix IV-62.

39. The initial discovery of HMX is noted in Bachmann and Sheehan, 1844. The pilot production of the material at the HSAAP during World War II is discussed in Carter, p. 47, Appendix IV-42, 43. On HMX production during the 1950's, see "Holston Army Ammunition Plant Historical Monograph," pp. 2. 19; Pridemore, p. 6.

40. The new acid facilities are noted in Pridemore, p. 2. According to Jim Levie, a Holston Defense Corporation Chemical Engineer who helped build the pilot maggie unit in 1952, the World-War-II experimental unit in Building b-303-B was dismantled to make way for the new equipment (telephone interview, May 18, 1983). On the development of power-recovery systems for ammonium oxidation facilities, see "Nitric Acid Plans Today," Chemical Engineering, 60 (November 1953), 150, 152; Newman and Klein, 63-64.

41. R.J. Hammond, "Profile on Munitions, 1950-1977," unpublished, n.d., pp. 82-82, microfiche in AMCCOM Historical Office; "$30 Million Holston Ammo Plant," undated newspaper clipping in Kingsport Industries File, Palmer Room, Kingsport Public Library; Pridemore, pp. 12-13, "Annual Unit History Holston Army Ammunition Plant, 1975-1976," unpublished report prepared by HSAAP, p. 9, in HSAAP Administrative Archives.

42. Holston Army Ammunition Plant Real Property Inventory; the Steam Plant Addition is described in Pridemore, "Holston Army Ammunition Plant, Unit History, Annual Supplement-CY 1968," unpublished report prepared by HSAAP, p. 4, in HSAAP Administrative Archives.

43. On equipment modifications, see Pridemore, "Unit History, 1942-1967," p. 24. Pridemore also notes that the four magnesium-nitrate concentration units installed in Building a-304 in 1965 originally were located at the Alabama Ordnance Works (p. 9). The information concerning the Plant-A acetic-acid operations comes from an interview with Hurd, April 13, 1983.

44. See the following unpublished reports in the HSAAP Administrative Archives: "Annual Unit History, 1975-1976," p. 8; "Annual Historical Review, 1977-1978," p. 14; "Annual Historical Review, 1978-1979," p. 13; "Annual Historical Review, 1979-1980," p. 14; "Annual Historical Review, 1980-1981," p. 13.

45. The ten-year modernization program is discussed in Holston Army Ammunition Plant, p. 4. The summary of recent construction activities is primarily derived from Holston Army Ammunition Real Property Inventory.

46. An excellent overview of the HSAAP's pollution concerns is found in "Unit History, Annual Supplement-CY 1968," pp. 3-8. On the holding pond and the Ammonium-Oxidation Plant, see "Holston Army Ammunition Plant, Unit History, 1972-1973," unpublished report prepared by HSAAP, pp. 7,11. On the electrostatic precipitators, see "Forward" of "Annual Unit History, 1975-1976," n.p.

Chapter 3

PRESERVATION RECOMMENDATIONS

BACKGROUND

Army Regulation 420-40 requires that an historic preservation plan be developed as an integral part of each installation's planning and long-range maintenance and development scheduling.[1] The purpose of such a program is to:

- Preserve historic properties to reflect the Army's role in history and its continuing concern for the protection of the nation's heritage.
- Implement historic preservation projects as an integral part of the installation's maintenance and construction programs.
- Find adaptive uses for historic properties in order to maintain them as actively used facilities on the installation.
- Eliminate damage or destruction due to improper maintenance, repair, or use that may alter or destroy the significant elements of any property.
- Enhance the most historically significant areas of the installation through appropriate landscaping and conservation.

To meet these overall preservation objectives, the general preservation recommendations set forth below have been developed:

Category I Historic Properties

All Category I historic properties not currently listed on or nominated to the National Register of Historic Places are assumed to be eligible for nomination regardless of age. The following general preservation recommendations apply to these properties:

a) Each Category I historic property should be treated as if it were on the National Register, whether listed or not. Properties not currently listed should be nominated. Category I historic properties should not be altered or demolished. All work on such properties shall be performed in accordance with Sections 106 and 110(f) of the National Historic Preservation Act as amended in 1980, and the regulations of the Advisory Council for Historic Preservation (ACHP) as outlined in the "Protection of Historic and Cultural Properties" (36 CFR 800).

b) An individual preservation plan should be developed and put into effect for each Category I historic property. This plan should delineate the appropriate restoration or preservation program to be carried out for the property. It should include a maintenance and repair schedule and estimated initial and annual costs. The preservation plan should be approved by the State Historic Preservation Officer and the Advisory Council in accordance with the above-referenced ACHP regulation. Until the historic preservation plan is put into effect, Category I historic properties should be maintained in accordance with the recommended approaches of the Secretary of Interior's Standards for Rehabilitation and

Revised Guidelines for Rehabilitating Historic Buildings[2] and in consultation with the State Historic Preservation Officer.

c) Each Category I historic property should be documented in accordance with Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER) Documentation Level II, and the documentation submitted for inclusion in the HABS/HAER collections in the Library of Congress.[3] When no adequate architectural drawings exist for a Category I historic property, it should be documented in accordance with Documentation Level I of these standards. In cases where standard measured drawings are unable to record significant features of a property or technological process, interpretive drawings also should be prepared.

Category II Historic Properties

All Category II historic properties not currently listed on or nominated to the National Register of Historic Places are assumed to be eligible for nomination regardless of age. The following general preservation recommendations apply to these properties:

a) Each Category II historic property should be treated as if it were on the National Register, whether listed or not. Properties not currently listed should be nominated. Category II historic properties should not be altered or demolished. All work on such properties shall be performed in accordance with Sections 106 and 110(f) of the National Historic Preservation Act as amended in 1980, and the regulations of the Advisory Council for Historic Preservation (ACHP) as outlined in the "Protection of Historic and Cultural Properties" (36 CFR 800).

b) An individual preservation plan should be developed and put into effect for each Category II historic property. This plan should delineate the appropriate preservation or rehabilitation program to be carried out for the property or for those parts of the property which contribute to its historical, architectural, or technological importance. It should include a maintenance and repair schedule and estimated initial and annual costs. The preservation plan should be approved by the State Historic Preservation Officer and the Advisory Council in accordance with the above-referenced ACHP regulations. Until the historic preservation plan is put into effect, Category II historic properties should be maintained in accordance with the recommended approaches in the Secretary of the Interior's <u>Standards for Rehabilitation and Revised Guidelines for Rehabilitating Historic Buildings</u>[4] and in consultation with the State Historic Preservation Officer.

c) Each Category II historic property should be documented in accordance with Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER) Documentation Level

II, and the documentation submitted for inclusion in the HABS/HAER collections in the Library of Congress.[5]

Category III Historic Properties

The following preservation recommendations apply to Category III historic properties:

a) Category III historic properties listed on or eligible for nomination to the National Register as part of a district or thematic group should be treated in accordance with Sections 106 and 110(f) of the National Historic Preservation Act as amended in 1980, and the regulations of the Advisory Council for Historic Preservation as outlined in the "Protection of Historic and Cultural Properties" (36 CFR 800). Such properties should not be demolished and their facades, or those parts of the property that contribute to the historical landscape, should be protected from major modifications. Preservation plans should be developed for groupings of Category III historic properties within a district or thematic group. The scope of these plans should be limited to those parts of each property that contribute to the district or group's importance. Until such plans are put into effect, these properties should be maintained in accordance with the recommended approaches in the Secretary of the Interior's Standards for Rehabilitation and Revised

Guidelines for Rehabilitating Historic Buildings[6] and in consultation with the State Historic Preservation Officer.

b) Category III historic properties not listed on or eligible for nomination to the National Register as part of a district or thematic group should receive routine maintenance. Such properties should not be demolished, and their facades, or those parts of the property that contribute to the historical landscape, should be protected from modification. If the properties are unoccupied, they should, as a minimum, be maintained in stable condition and prevented from deteriorating.

HABS/HAER Documentation Level IV has been completed for all Category III historic properties, and no additional documentation is required as long as they are not endangered. Category III historic properties that are endangered for operational or other reasons should be documented in accordance with HABS/HAER Documentation Level III, and submitted for inclusion in the HABS/HAER collections in the Library of Congress.[7] Similar structures need only be documented once.

CATEGORY I HISTORIC PROPERTIES

Producer-gas Plant (Plant A, Building 10)

- Background and significance. The Producer-Gas Plant (see Figure 14 and page 55, note 25) was built in 1943 as an integral part of the

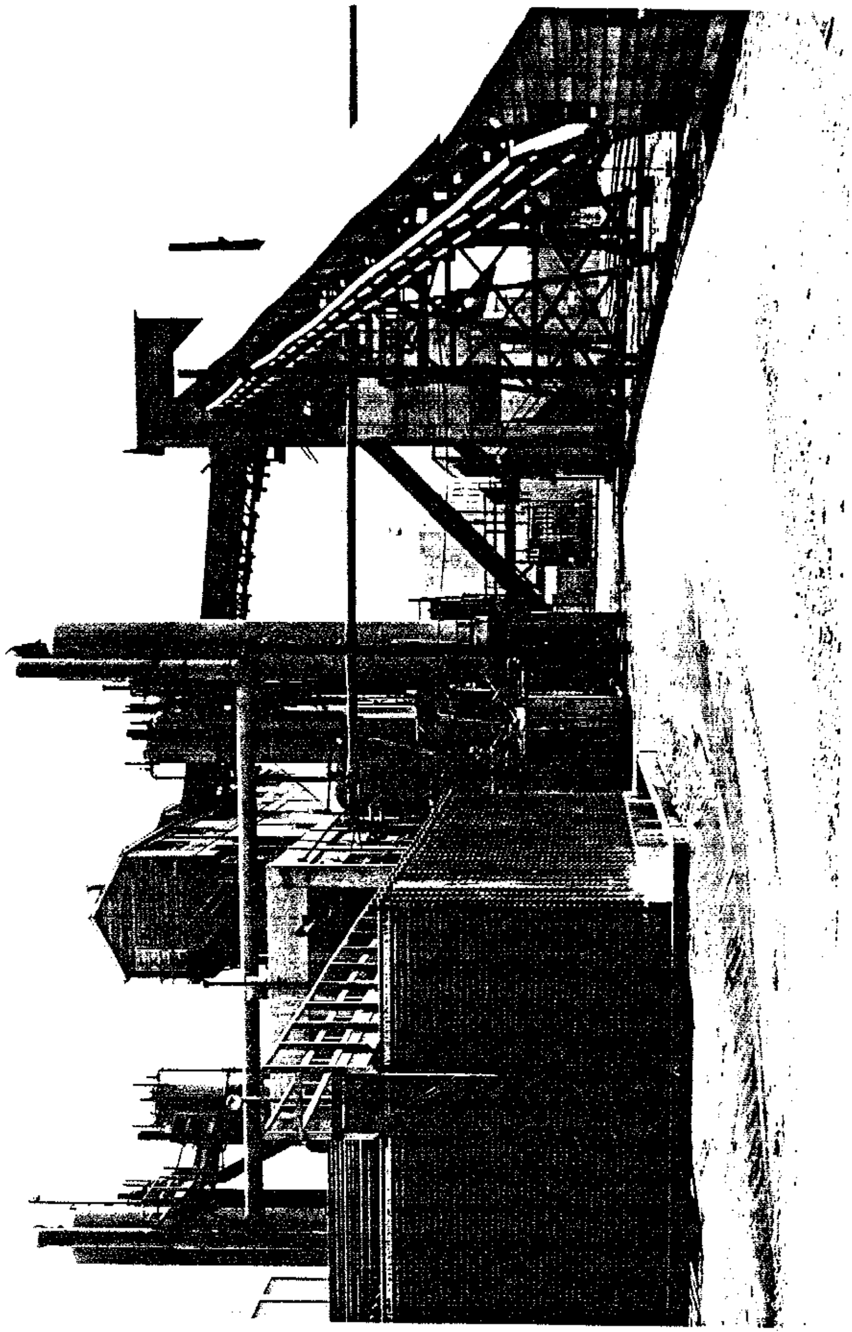

Figure 14: Producer-Gas Plant (Plant A, Building 10), southeast elevation. (Source: "Industrial Facilities Inventory," Part 1, Section 7, unpublished, prepared by U. S. Army Corps of Engineers, 1944, HSAAP Archives.)

acetic-anhydride manufacturing operation at Plant A. In its construction, the building mirrors the HSAAP's general utilitarian-industrial architectural style. It is primarily a four-story structure with an exposed reinforced-concrete structural frame on the first three stories and a gabled, wood-frame, coal-feed house on the top story. The coal-feed house is connected by an overhead conveyor to a coal ramp situated a few yards to the southeast. The Producer-Gas Plant contains twelve, updraft, fixed-bed producer units that convert bituminous coal and steam into a synthetic gas. The gas is piped to fuel cracking furnaces in Buildings 7 and 20 for use in acetic-anhydride production.

At the time of its construction, the plant's updraft-producer design represented "the simplest and commonest type" of producer-gas technology.[8] This technology had enjoyed its greatest American vogue during the 1920s, when approximately 12,000 producer-gas plants were in active industrial use. After this peak period, producer gas waned in popularity, largely because of "severe competition [from] natural gas and fuel oil." By 1948, there were less than 2,000 bituminous gas producers in operation, and the number continued to decline during the next three decades.[9] When the energy crisis of the mid-1970's revived industrial interest in producer-gas technology, it was discovered that the HSAAP had "one of the few gas producer facilities in operation in the United States."[10]

Architecturally, the Producer-Gas Plant is virtually unchanged since it was first placed in operation in 1943. And apart from minor modernization projects, such as the updating of its scrubbing trains for pollution-abatement purposes, the facility still retains its original equipment. As an exceedingly rare and highly intact example of a once common industrial process, the Producer-Gas Plant is a Category I historic property. For these reasons, it fulfills the "exceptional significance" criteria required by the National Register for properties less than fifty years old.[11] The Producer-Gas Plant should be nominated to the National Register as part of a thematic group that includes the other significant historic properties at the HSAAP.

- Condition and potential adverse impacts. Architecturally and technologically, the Producer-Gas Plant is in good condition. There are no current plans to alter or demolish this structure, but continued maintenance and repair of the facility is needed to ensure its preservation.

- Preservation options. See the general preservation recommendations at the beginning of this chapter for Category I historic properties.

RDX-and-Composition-B Manufacturing Lines (Plant B)

- Primary Distillation Buildings (Buildings B1, B3, B5, B7, B9)
- Collection Buildings (Buildings C1, C3, C5, C6, C7, C9)
- Nitration Buildings (Buildings D1-D10)
- Washing Buildings (Buildings E1-E10)
- Recrystallization Buildings (Buildings G1-G10)

- Dewatering Buildings (Buildings H1-H10)
- Incorporation Buildings (Buildings I1-I10, J1-J10, L1-L10, M1-M10)
- TNT-Opening Buildings (Buildings K1-K10)
- Packaging Buildings (Buildings N1-N10)
- Laboratories (Buildings 01, 03, 05, 07, 09)

Background and significance. Constructed during 1942-1944, these 116 buildings are the heart of the HSAAP manufacturing operation. Situated on an isolated tract of bottomland bordering the north bank of the Holston River in Plant B, they are organized into ten nearly identical production lines for RDX and Composition B (see Figures 15-23). With the exceptions of Building D4, which was partially demolished after a fire in 1957, and Building G10, which was doubled in size in 1968, the structures survive virtually intact.

Taken as an ensemble, these production buildings constitute a unique technological system of major historical importance. The HSAAP's ten RDX-and-Composition-B manufacturing lines represent the world's first large-scale industrial application of the Bachmann method, which revolutionized the production of RDX and Composition B by replacing an expensive, labor-intensive batch technology with a cost-efficient, mass-production operation. During World War II, the HSAAP was (and it still is) the only American Bachmann-method plant, and it accounted for approximately ninety percent of the country's output of Composition B, which was extensively used in Allied ordnance.

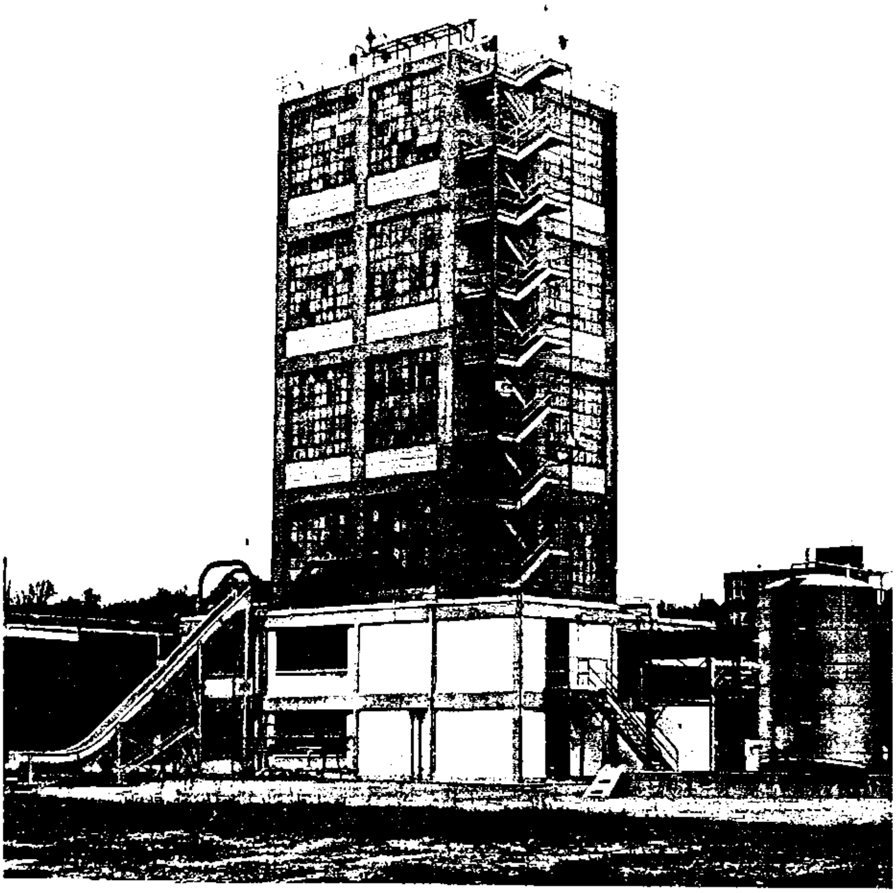

Figure 15: Building B3 is representative of the Primary Distillation Buildings in the RDX-and-Composition-B manufacturing lines. (Source: Field inventory photograph, 1983, Jeffrey A. Hess, MacDonald and Mack Partnership.)

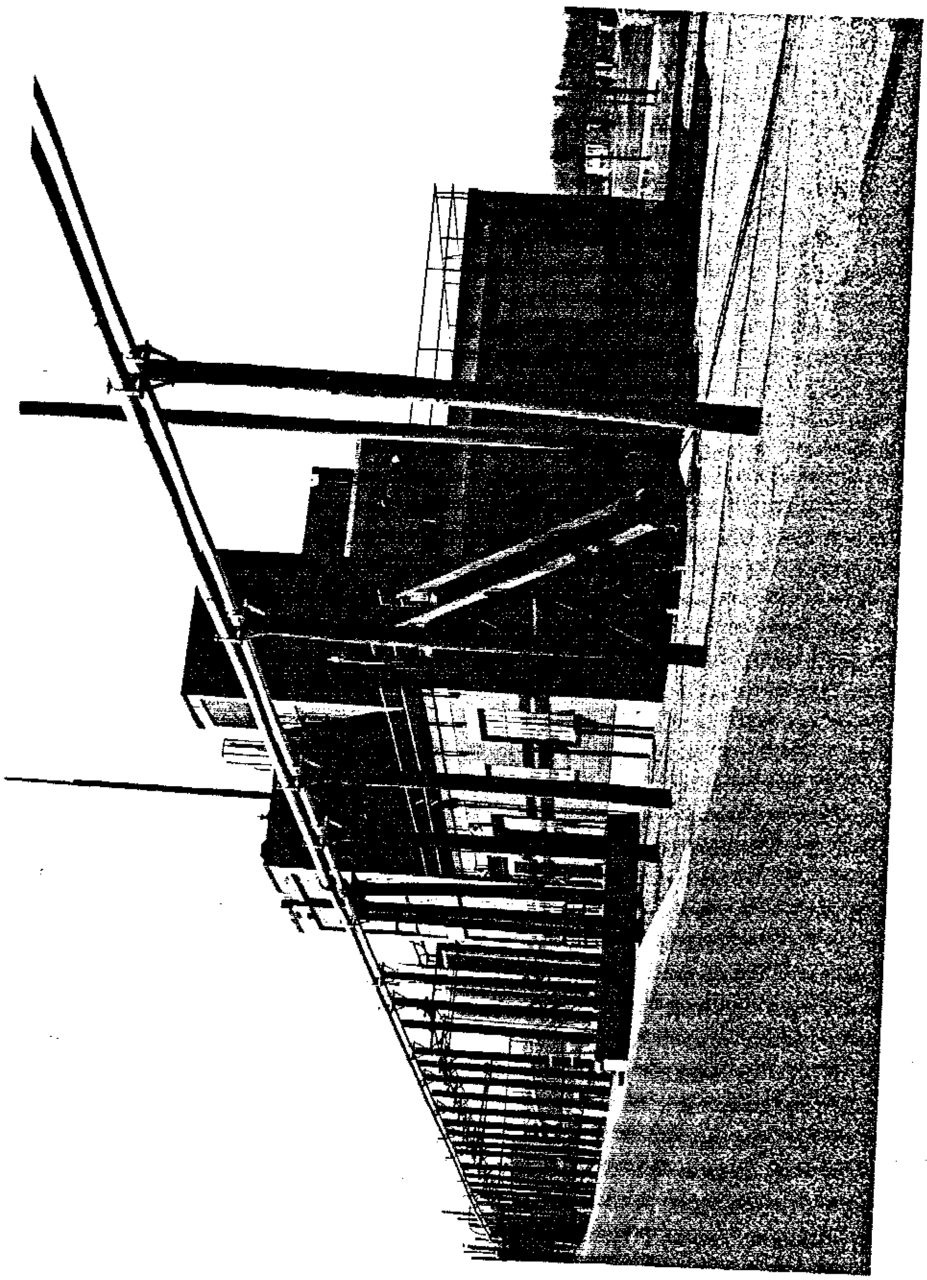

Figure 16: Building C9 is representative of the Collection Buildings in the RDX-and-Composition B manufacturing lines at the Holston Army Ammunition Plant. (Source: Field inventory photograph, 1983, Jeffrey A. Hess, MacDonald and Mack Partnership.)

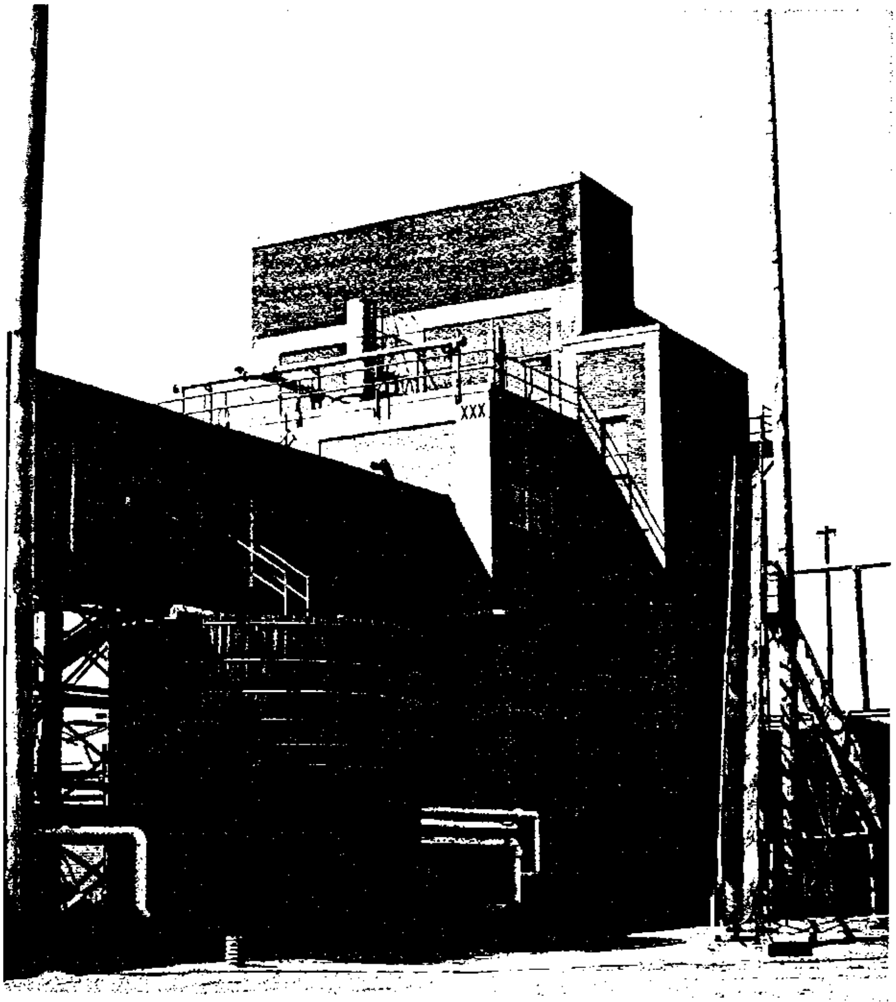

Figure 17: Building D10 is representative of the Nitration Buildings in the RDX-and-Composition-B manufacturing lines at the Holston Army Ammunition Plant. (Source: Field inventory photograph, 1983, Jeffrey A. Hess, MacDonald and Mack Partnership.)

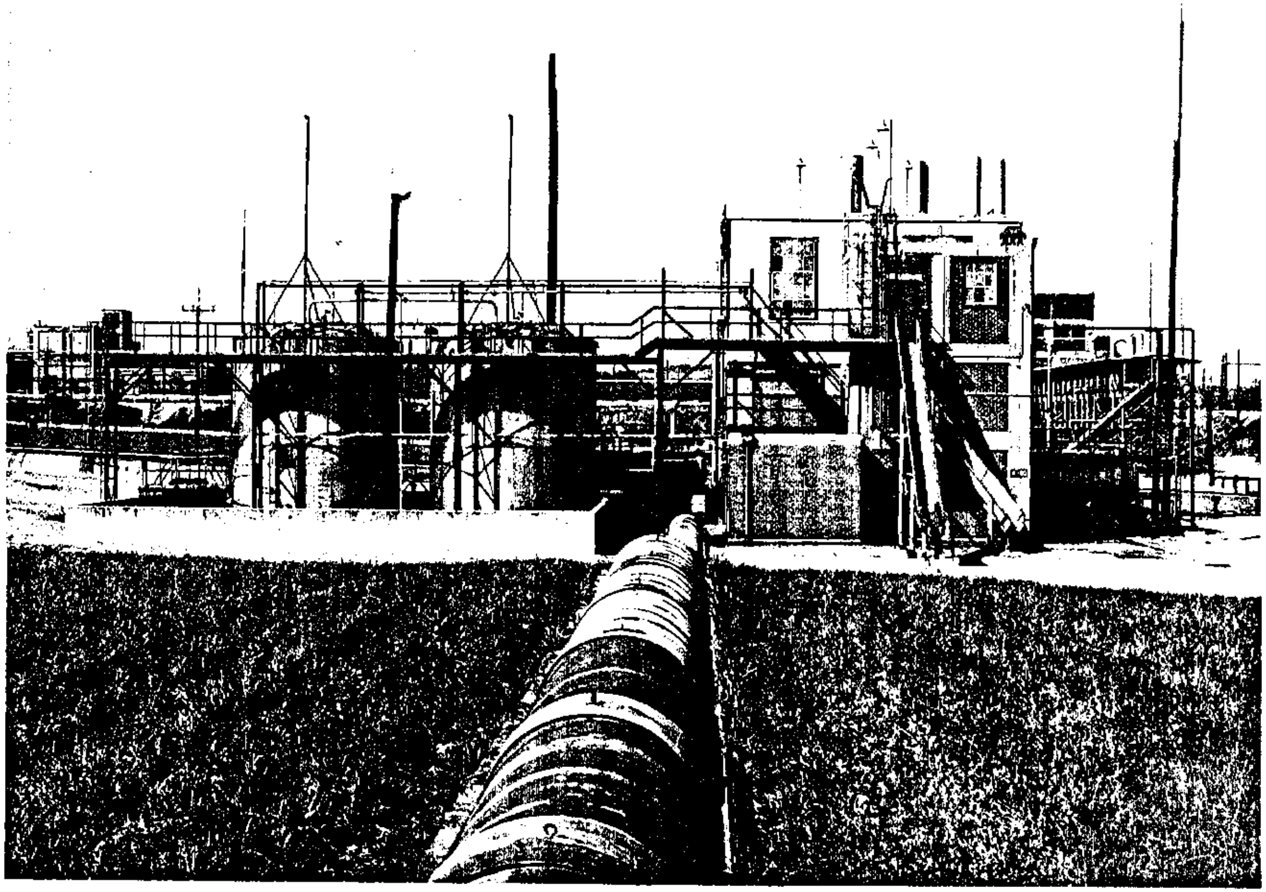

Figure 18: Building E10 is representative of the Washing Building in the RDX-and-Composition-B manufacturing lines at the Holston Army Ammunition Plant. The piping in the foreground transports partially purified RDX slurry from the Washing Building to the Recrystallization Building (G10). (Source: Field inventory photograph, 1983, Jeffrey A. Hess, MacDonald and Mack Partnership.)

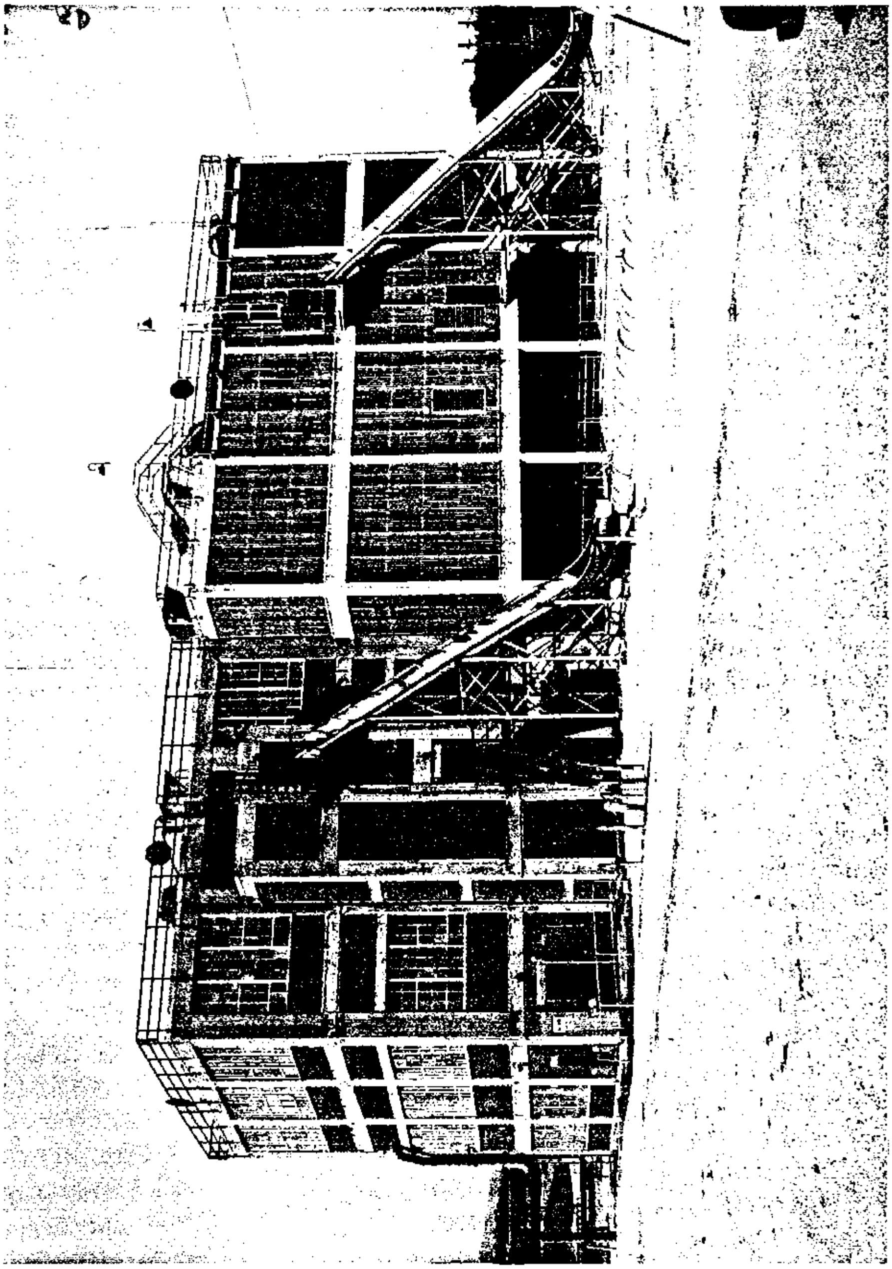

Figure 19: Building G10, with a projecting addition (Building G10A) constructed in 1968. Except for the addition, Building G10 is representative of the Recrystallization Buildings in the RDX-and-Composition-B manufacturing lines at the Holston Army Ammunition Plant. (Source: Field inventory photograph, 1983, Jeffrey A. Hess, MacDonald and Mack Partnership.)

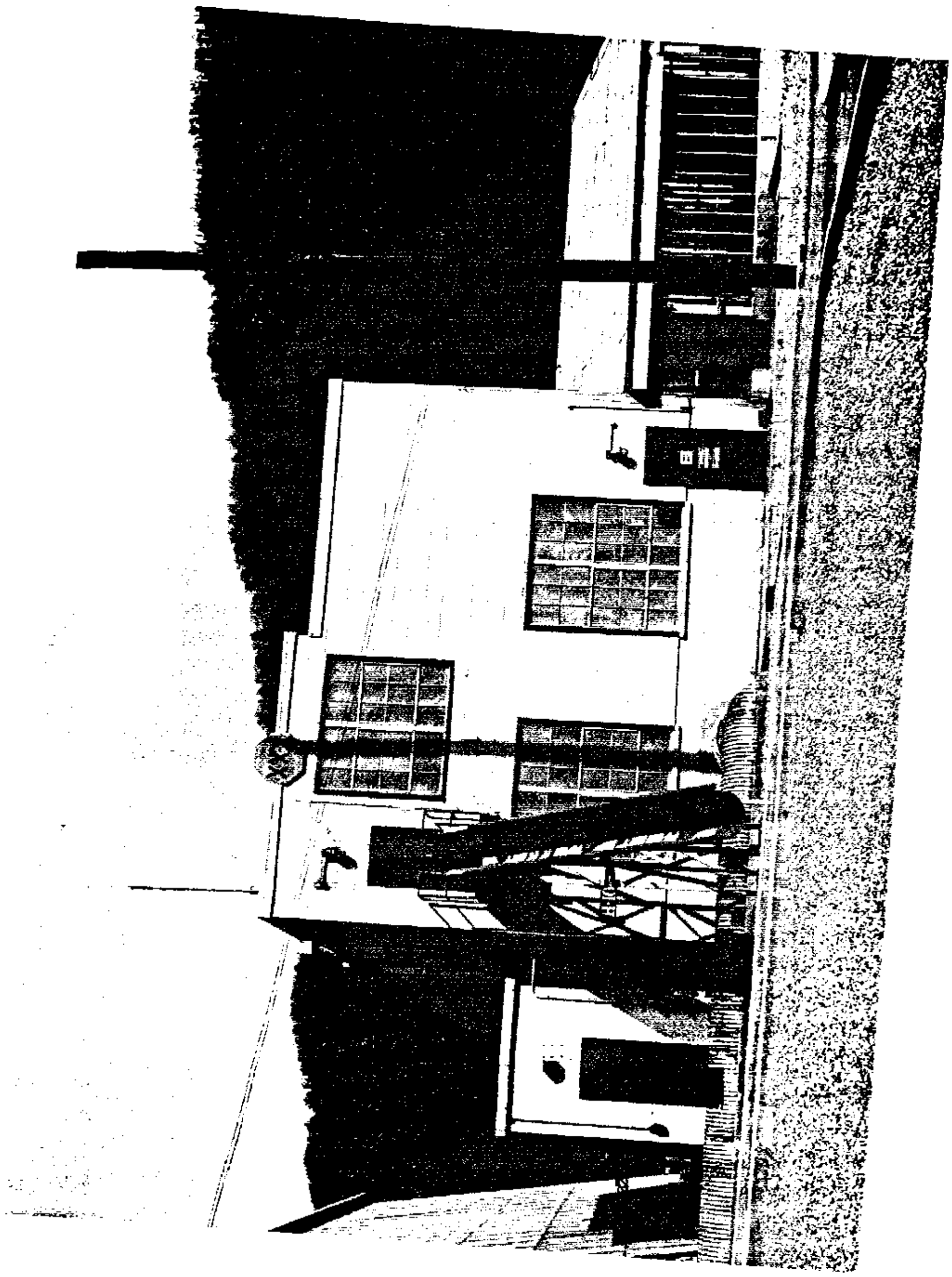

Figure 20: Building H10 is representative of the Dewatering Buildings in the RDX-and-Composition-B manufacturing lines at the Holston Army Ammunition Plant. (Source: Field inventory photograph, 1983, Jeffrey A. Hess, MacDonald and Mack Partnership.)

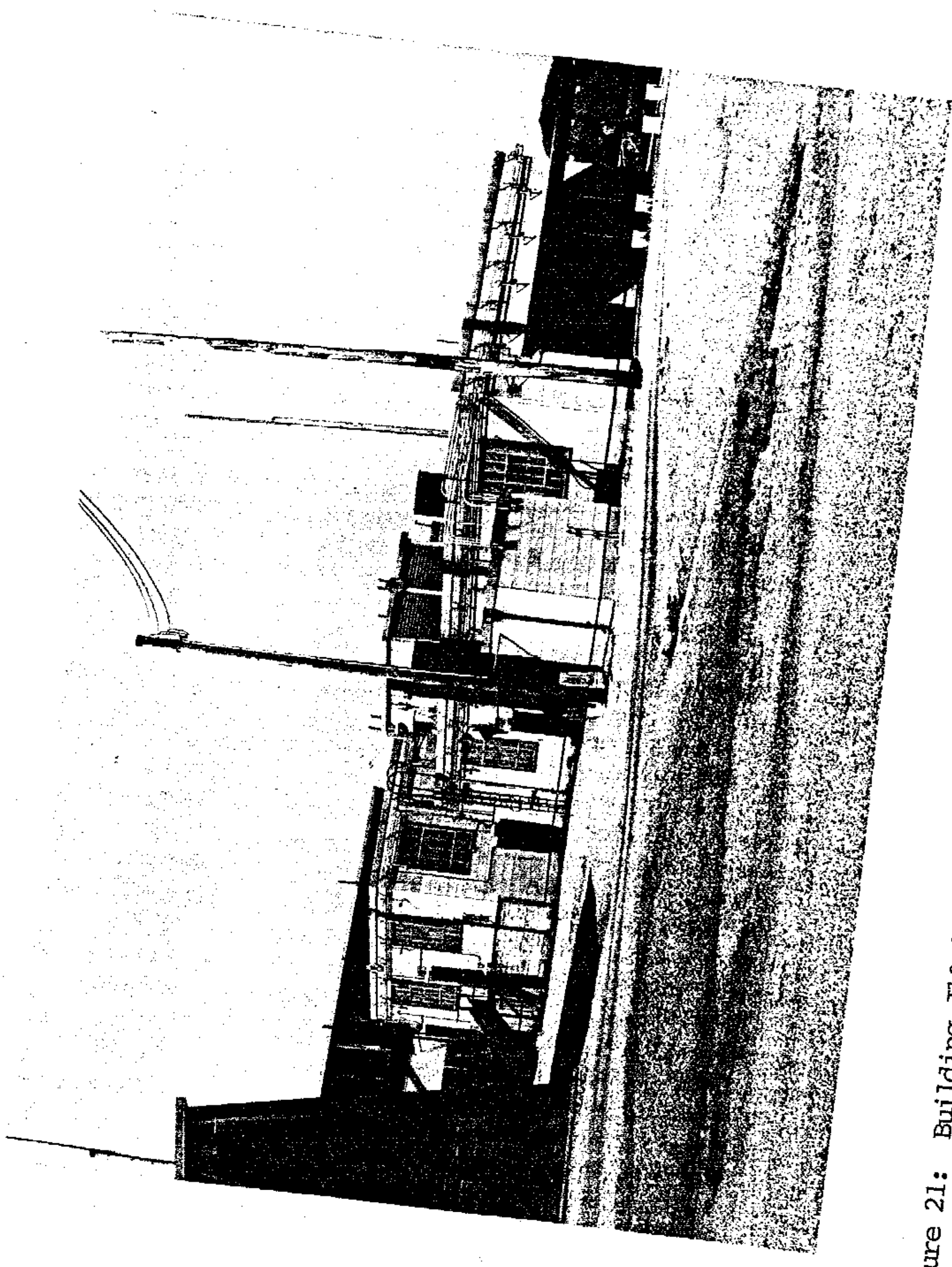

Figure 21: Building J10 is representative of the other thirty-nine Incorporation Buildings in the RDX-and-Composition-B manufacturing lines at the Holston Army Ammunition Plant. In the Incorporation Buildings, RDX is mixed with molten TNT to form Composition B. (Source: Field inventory photograph, 1983, Jeffrey A. Hess, MacDonald and Mack Partnership.)

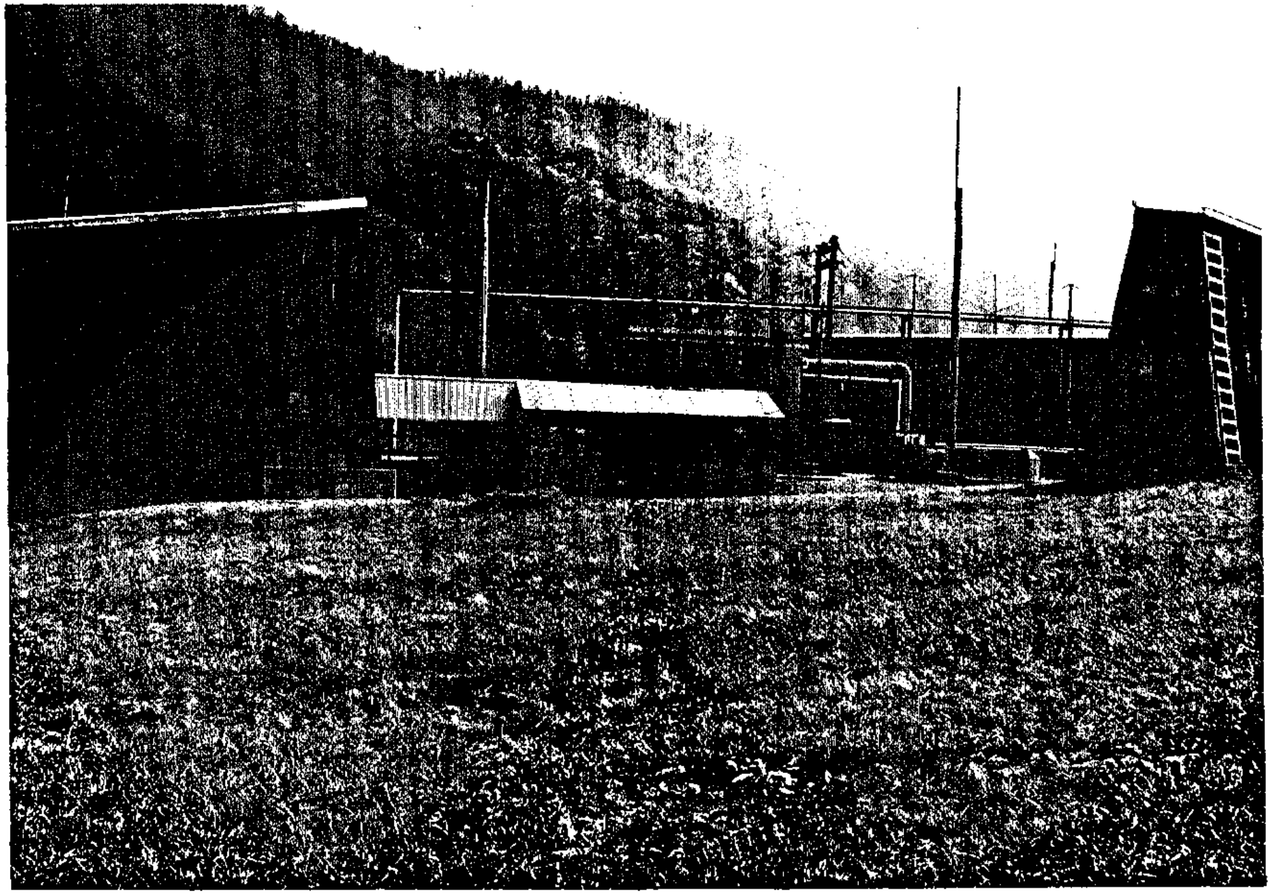

Figure 22: Building K10 is representative of the other TNT-Opening Buildings in the RDX-and-Composition-B manufacturing lines at the Holston Army Ammunition Plant. It is also similar to the Packaging Buildings (N Buildings) in the lines. After TNT is uncrated in the K Buildings, it is delivered via wood-frame, covered, wheeling ramps (in foreground of photograph) to the Incorporation Buildings for blending with RDX to form Composition B. (Source: Field inventory photograph, 1983, Jeffrey A. Hess, MacDonald and Mack Partnership.)

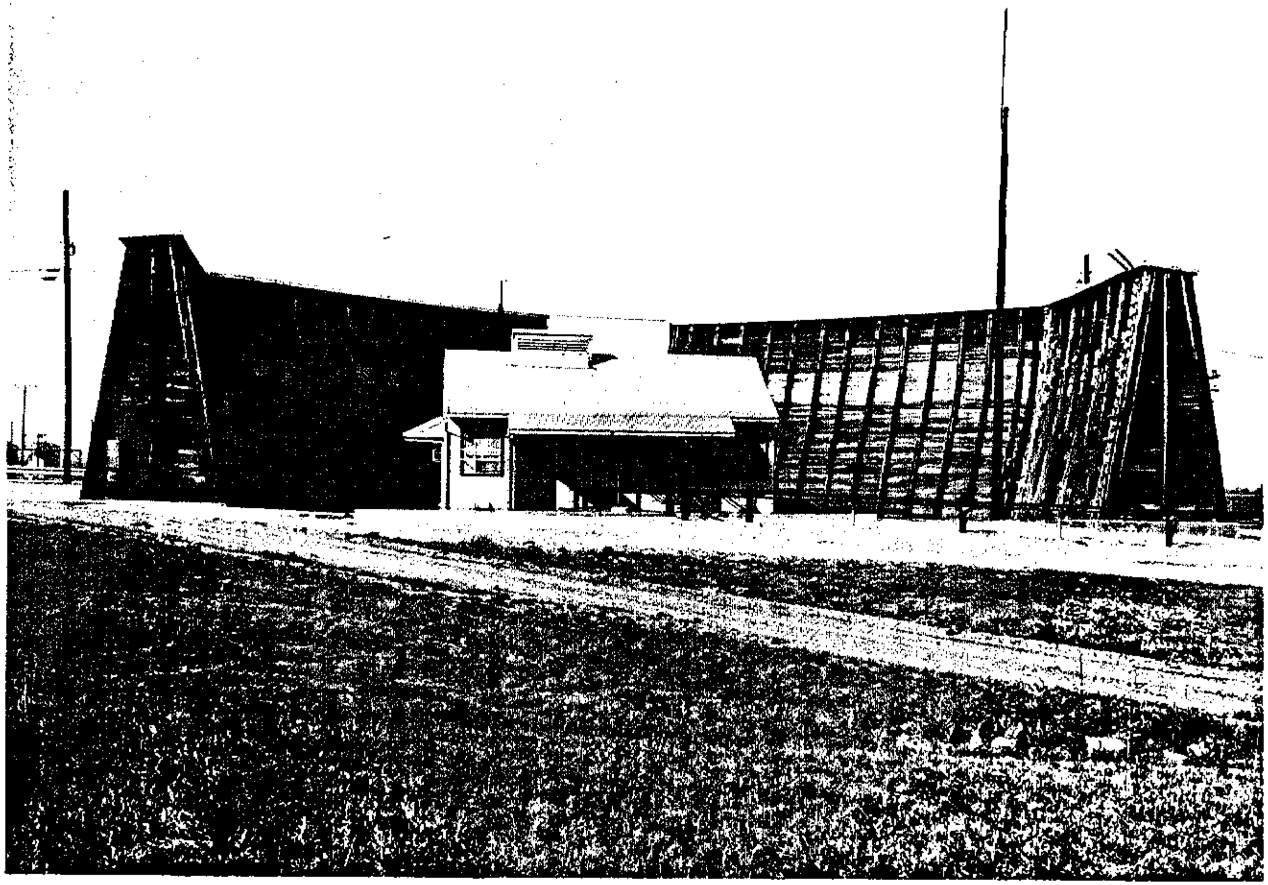

Figure 23: Building 09 is representative of the Field Laboratory Buildings used for quality control in the RDX-and-Composition-B manufacturing lines at the Holston Army Ammunition Plant. The wooden barricade is designed to protect other plant facilities from the effects of a possible explosion in the Laboratory. (Source: Field inventory photograph, 1983, Jeffrey A. Hess, MacDonald and Mack Partnership.)

Combined with aluminum powder at loading plants to form the explosive "Torpex," Composition B was particularly effective in underwater munitions, having almost twice the power of conventional TNT-loaded torpedos and depth charges. Torpex torpedos were of such supreme strategic importance that they were carefully rationed during the early years of the war:

> Originally issued to submarines with the best record of kills, the new product was distributed throughout the submarine fleet as fast as production permitted. Ship sinkings increased, and the Bureau [of Naval Ordnance] received reports that Torpex torpedos were able to break vessels in two. Comparative tests with captured enemy munitions showed that neither the Germans nor the Japanese possessed explosives as powerful as Torpex.[12]

As one historian of the HSAAP has noted, "Holston's greatest accomplishment . . . was its role in winning the Battle of the Atlantic, [which was] acknowledged by both the United Nations and the Axis alike as the most important single phase of the war." The large volume of Composition B produced at the HSAAP also "in great measure paved the way for the invasion of the European continent and for the final destruction of the Japanese war effort."[13]

Because of their pivotal role in the Allied war effort, the 116 buildings in the HSAAP's ten RDX-and-Composition-B manufacturing lines are Category I historic properties. They fulfill the "exceptional significance" criteria required by the National Register for properties less than fifty years of age.[14] They should be nominated to the National Register as part of a thematic group that includes the other significant historic properties at the HSAAP.

- <u>Condition and potential adverse impacts</u>. Apart from Building D4, which was partially demolished and vacated after a fire in 1957, all buildings in the district survive in good condition. The buildings have experienced varying degrees of equipment modification, with the greatest alterations to the original Bachmann-method apparatus occuring in Lines 1 and 2. There are no current plans to alter or demolish any of these structures, but continued maintenance and repair of the district is needed to ensure its preservation.

- <u>Preservation options</u>. There is no need to preserve all ten of the RDX-and-Composition-B manufacturing lines, but at least one complete and fully equipped line should be selected, in consultation with appropriate Army personnel, on the basis of its condition and location for permanent retention as an historic district. The line should include a representative B Building, and a linear arrangement of Buildings C, D, E, G, H, I, J, K, L, M, N and O, along with such auxiliary structures as barricades and wheeling ramps. The buildings in the designated line should be subject to the general preservation recommendations for Category I historic properties, as discussed at the beginning of this chapter. Since the HSAAP is a functioning plant with modernization requirements, the Category I preservation recommendations should be waived for the other nine manufacturing lines when deemed necessary by military planners.

CATEGORY II HISTORIC PROPERTIES

There are no Category II historic properties at the Holston Army Ammunition Plant.

CATEGORY III HISTORIC PROPERTIES

Old Administration Building (Plant B, Building 1)

- Background and significance. Constructed in 1943 to serve as post headquarters for the HSAAP, Building 1 (Figure 5) is located in the administration area of Plant B. Comprising three parallel wings connected by a central circulation spine, the building is a two-story, brick structure with a wood-frame hip roof. In keeping with the installation's industrial-utilitarian character, the Old Administration Building has only minimal architectural detailing: pilasters separating window groups, contrasting spandrels, and a wood-fame, cross-gabled, entrance portico centered on the main facade. The structure functioned as post headquarters until 1980, when a new administration building was completed. It is currently used as an office building by the Naval Reserve. Because of the building's direct association with the HSAAP's nationally significant, World-War-II manufacturing program, it is a Category III historic property. It should be nominated to the National Register as part of a thematic group that includes the other significant historic properties at the HSAAP.

• <u>Condition and potential adverse impacts</u>. The Old Administration Building is in good condition and receives routine maintenance and repair. It closely resembles its original condition. There are no current plans to alter or demolish the structure.

<u>Preservation options</u>. See the beginning of this chapter for general preservation recommendations for Category III historic properties that are eligible for the National Register as part of a thematic group.

NOTES

1. <u>Army Regulation 420-40, Historic Preservation</u> (Headquarters, U.S. Army: Washington, D.C., 15 April 1984).

2. National Park Service, <u>Secretary of Interior's Standards for Rehabilitation and Revised Guidelines for Rehabilitating Historic Buildings, 1983</u> (Washington, D.C.: Preservation Assistance Division, National Park Service, 1983).

3. National Park Service, "Archeology and Historic Preservation; Secretary of the Interior's Standards and Guidelines," <u>Federal Register</u>, Part IV, 28 September 1983, pp. 44730-44734.

4. National Park Service, <u>Secretary of the Interior's Standards</u>.

5. National Park Service, "Archeology and Historic Preservation."

6. National Park Service, <u>Secretary of the Interior's Standards</u>.

7. National Park Service, "Archeology and Historic Preservation."

8. B. J. C. Van Der Hoeven, "Producers and Producer of Gas," <u>Chemistry of Coal Utilization</u>, vol. 2 (New York: John Wiley & Sons, Inc., 1945), p. 1659.

9. Basil W. Waring and John F. Foster, "Producer Gas," <u>Economics of Fuel Gas from Coal</u>, eds. John F. Foster and Richard J. Lund (New York: McGraw-Hill Book Company, Inc., 1950), pp. 15-16.

10. Holston Army Ammunition Plan, Annual Historical Review, 1 October 1978 - 30 September 1979," unpublished report prepared by HSAAP, in Administrative Archives, HSAAP.

11. Marcella Sherfy and W. Ray Luce, "How to Evaluate and Nominate Potential National Register Properties that Have Achieved Significance within the Last 50 Years" (Washington, D.C.: U.S. Department of the Interior, Heritage Conservation and Recreation Service, 1979).

12. Buford Rowland and William B. Boyd, U.S. Navy Bureau of Ordnance in World War II (Bureau of Ordnance, Department of the Navy, n.d.), p. 206.

13. Ellen Crawford, "Full Story of HOW Product," Kingsport Times-News, December 9, 1945.

14. Sherfy and Luce.

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